NASA PROCUREMENT IN THE EARTH-SPACE ECONOMY

Y 4.SCI 2:104/33

NASA Procurement in the Earth-Space...

HEARING

BEFORE THE

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

ONE HUNDRED FOURTH CONGRESS

FIRST SESSION

NOVEMBER 8, 1995

[No. 33]

Printed for the use of the Committee on Science

MAY 06 1999

U.S. GOVERNMENT PRINTING OFFICE

22-267CC WASHINGTON : 1996

For sale by the U.S. Government Printing Office
Superintendent of Documents, Congressional Sales Office, Washington, DC 20402
ISBN 0-16-052423-7

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NASA PROCUREMENT IN THE EARTH-SPACE ECONOMY

WEDNESDAY, NOVEMBER 8, 1995

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE
Washington, DC.

The committee met at 11:05 a.m. in Room 2318 of the Rayburn House Office Building, the Honorable Robert S. Walker, chairman of the committee, presiding.

The CHAIRMAN. The hearing will come to order.

Let me begin first by apologizing to our witnesses and to those of you in attendance in the audience for any inconvenience caused by the rescheduling of our hearing this morning. At the last moment, a meeting of the Republican Members of the House was scheduled at 10:00 to discuss a vote on a possible commitment of American troops to peacekeeping in Bosnia. So we thought that we ought to be sensitive to that. That's a very important decision that's going to affect a lot of people, and we decided to postpone the meeting so some of us, at least, could be in attendance at that conference for a period of time.

Let me talk a little bit about today's hearing, NASA Purchasing in the Earth-Space Economy. That will mean different things to different people.

To some people, this is an opportunity for small space technology firms to complain about how NASA policies have edged them out of realizing their vision to commercialize a space project.

For others, this is an opportunity for Congress to contemplate what policies should govern the transactions between Earth-based businesses and the International Space Station.

To others, this is a hearing about changing NASA's culture and mindset to encourage space entrepreneurship.

To others, this is a hearing about changing NASA's procurement policies so that some of the world's best technology companies would be willing at last to apply their brilliance to the conquest of space.

To others, this is a hearing about how best to preserve the strategic edge provided by the American aerospace industrial base by making them seek profits, not just government contracts, in a post-Cold War era.

In short, we have a lot of loose ends to tie up, all of which relate to each other, and which must ultimately be addressed before America has the transactions and interactions in space that she is truly capable of.

Let there be no doubt, the economic forces of the future that will lift huge constellations of satellites are the same as those which will lift our spirits in the human exploration of space. It will be, as someone put it, Adam Smith's "invisible hand" that will do the heavy lifting of carrying space infrastructure into space, and not the heavy hand of the government. Adam Smith, not Uncle Sam, will shortly become the nation's preeminent space architect.

Everywhere you look, space budgets are increasing in private hands and decreasing in public hands. If NASA is to achieve the institutional security it needs during this era of global government downsizing, it must plug itself into the renewable space program growing all around NASA, and I suspect we will hear today, growing in many cases in spite of NASA.

As we look toward the operation of the International Space Station, it's important that we have the right attitude now, so that when the space station is built, it doesn't become the last socialist republic in the galaxy. Every republic on Earth, at least, is in the global movement toward reduced government control over economics. It's fundamental that the International Space Station use markets to decide who does what, instead of issuing government decrees and dividing work between the space bureaucracies.

Well, as you see, we're not only talking about a new way of business, but really a new way of thinking. We have a long way to go yet, to be sure. But let's at least agree that there is a great risk from failing to change. If the American government can't buy the very best space program in the world by working in partnership with the very best technology companies in America, other governments can and will.

During the Apollo era, NASA was the unquestioned cutting edge technology force of the United States and America clearly led the world. NASA even taught businesses how to manage the modern technology enterprise. Now the tables have turned, yet NASA fails to see private enterprise as a source of strength; instead, NASA sees private space entrepreneurs as competing with them.

The problem is, given the globalization of the economy and the availability of risk capital to perform tasks that used to be the sole province of government, NASA is going to lose if it competes with industry. In the end, NASA has but one choice: join up with the entrepreneurs, or be left in the technological dust.

Nations that choose to buy space technology smartly and quickly will get smart technology faster. If not, America will lose its strategic edge, not because the strategic technologies do not exist or are not for sale, but because they can't be bought at any price through the government's procurement system.

The NASA procurement system requires too much paperwork for small companies to afford dealing with NASA, and requires surrendering too much intellectual property for smart companies to want to deal with NASA. If small, smart companies can't be a part of the NASA network, just who does that leave us with?

In fairness, NASA has worked to reform the procurement process and make it more user-friendly and less onerous. We applaud those efforts. We applaud the process of reinvention. But systemic changes are needed as well.

I believe we are at a crisis point when the only way to assure small commercial companies have access to the Shuttle is for Congress to complain about it.

I believe we are at a crisis point when NASA refuses to do business with commercial space firms because their own civil servants would lose control over an activity.

I believe we are at a crisis point when NASA hides behind the procurement laws instead of standing behind the Space Act.

The impression given by all of this is that government's procurement process is little more sophisticated than dividing up money and giving it to the same traditional space companies.

Sadly, the mountains of paperwork facing small, competitive companies, and other hazards that scare away the best technology companies from even wanting to deal with NASA, more closely resemble a protection racket for the big, traditional NASA contractors than it does achieving value for the American taxpayer.

Finally, our nation fully funded and won the Cold War in large part because we were able to harvest superior technology and maintain a strategic edge against our potential enemies. That didn't happen because we had a bigger government than the Soviet Union. No, it happened because we had a better system, a free market, that demands more from people's abilities than governments do. We owe our technological edge to private inventiveness and ingenuity, the ability to make decisions quickly and to take risks. These are the qualities which even the most traditional aerospace companies must value in order to survive in a new era.

NASA must value these qualities, too, or it won't survive. The problem now is that people are demanding to go to space and wondering why their government can't get them there. If we can make NASA an integral part of the Earth-space economy by reforming NASA's procurements to take advantage of the nation's total economic ability to be a spacefaring nation, there won't just be a will. There will also be a way.

I thank you, and I would turn to Mr. Hall for any opening statement that he might have.

Mr. HALL. Thank you very much, Mr. Chairman.

I certainly look forward to today's hearing. It was an opportunity to get an update on the progress of NASA's procurement reforms.

I think it's a subject that obviously I've had a very keen interest in for a long, long time, and we need to know and make sure that NASA's spending the American taxpayer's money efficiently as it carries out its missions. I think it's hard to talk about the taxpayer's money, though, without tipping my hat to the NASA administrator and those around him who have helped guide the space agency through cuts in funding plans of more than 30 percent the last three years. I don't know of any other entity that's done that, and done it with the class that NASA has done it.

I think NASA has absolutely been a model for the rest of the Federal Government in its willingness to step up to that challenge. Because we called so many times and asked them to show us where they could cut, because we didn't really want to hurt the program. We wanted to help the program. But not having the sophistication nor the background nor the scientific bedrock that you folks have, we didn't really know how to intelligently really just

force a cut. We could do it with a baseball bat, but obviously it's better if it could be done with a surgeon's knife, and that's the way it's been.

And I'm very grateful for that, and grateful for the time and the hours that people like you, and of course Dan Goldin and others, have put in.

It's been said that NASA's procurement system is where the rubber meets the road, and that's very true. Because in obtaining the goods and services needed by the civil space program, you've had to be realistic, and you have been realistic, and I'm grateful for it.

I think it's the system that has to be working effectively if we're going to avoid waste, and that's what we want to do. I think it almost goes without saying that NASA's procurement system has to work hand in hand with the administrator's efforts to manage NASA under the very severe budgetary constraints that we're all facing up here now. They're a fact of life.

This Committee and this Chairman, and the Subcommittee on Space in particular, have held a lot of hearings on NASA's procurement practices over the last several years, and I think NASA's made significant progress during that period. And I believe that the testimony of Mrs. Lee, who's head of—NASA's Associate Administrator for Procurement—is going to reflect that, and I look forward to it.

Finally, I thank the Chairman, and I'd like to welcome the other witnesses who'll be offering testimony here today. I thank you for your time, not just the time it took to travel here, but the backup time; maybe even the time you put at the university to bring yourself to the position where you have these gifts to give to your country. But I thank you personally for these days that you've put in, and that you're here today. You play such an important role in realizing the practical benefits that space exploration offers to our citizens, and I look forward to your testimony.

We seem to need—I need, and I find a lot of times that I need—a card that sets out the benefits of the exploration, not just the MRI and the CAT scan and all these other things. But some time, I'd like to have time and have a panel of people who would go back to the splitting of the atom and see really how many gifts and how many projects that we've received because of your pursuit.

Mr. Chairman, I yield back my time.

The CHAIRMAN. Thank you, Mr. Hall.

Are there any other members that wish to make opening statements?

Mrs. MORELLA. Mr. Chairman.

The CHAIRMAN. Mrs. Morella.

Mrs. MORELLA. Thank you.

I'd like to ask unanimous consent that an opening statement in its entirety be included in the record.

The CHAIRMAN. Without objection.

Mrs. MORELLA. I want to thank you for calling this hearing, which I think is critically important as we discuss NASA's procurement processes, its ability to reduce costs by acting as a normal commercial customer in the high-technology marketplace, and its ability to meet our national goals to promote space commercialization as a routine part of NASA's operations.

The commercial space industry is in a very delicate state of development, and our hearing today should really help us to understand the rise of this commercial space industry, and the roles that NASA plays in helping it. NASA is first and foremost the largest consumer of civil space technology in the country, if not the world, and yet its procurement practices suffer from all the problems we find in the world of defense procurement and which the Department of Defense is trying to fix with its National Security Science and Technology Strategy.

Better procurement practices that enable NASA to act as a normal commercial customer in the high-tech marketplace will help promote commercial development and lower NASA's costs. Still, we need to consider new approaches to NASA's work with the private sector. The agency is used to working with large aerospace companies who traditionally define profit in terms of their ability to win government contracts. And yet, the new commercial space companies will earn their profit by providing goods and services to the private sector.

Thus, they have different needs from government. And the traditional government contractor-procurement relationship will not apply.

So I think, Mr. Chairman, our witnesses today will help us define these new relationships in order to bring the Earth-space economy to fruition. And I thank you.

I yield back the balance of my time.

The CHAIRMAN. Thank you, Mrs. Morella.

Are there any other members?

Mr. HALL. Mr. Chairman, I ask unanimous consent to put Minority Leader George Brown's statement in the record.

The CHAIRMAN. Without objection.

[The prepared statements of Mrs. Morella and Mr. Brown follow:]

Constance Morella

~~Draft~~ Opening Statement
The Honorable Connie Morella
House Committee on Science
Hearing: NASA Purchasing in the Earth-Space Economy
November 8, 1995

I thank you, Chairman Walker, for calling this important hearing.
~~Good morning ladies and gentlemen and welcome to this hearing of the House Committee on Science.~~ We are meeting today to discuss NASA procurement processes, its ability to reduce costs by acting as a normal commercial customer in the high technology marketplace, and its ability to meet our national goals to promote space commercialization as a routine part of NASA's operations.

Originally created to help us win the political competition with the Soviet Union, NASA faces new challenges in the post Cold War world. We can expect NASA's record of accomplishments in basic science and technology to continue to reward the United States.

Fortunately, we have also arrived at a period in time when the long-promise of commercial space development is finally beginning to become reality. The space communications business has long been a shining star in successful space commercialization, but it was lonely star for a very long time.

Now, the private sector is beginning to demonstrate that it has the technical expertise, the management experience, and the private financing needed to create space infrastructure and capabilities on its own. Soon, several companies will launch constellations of low-earth orbit satellites for mobile communications around the world. Next year, the first privately financed and developed remote sensing satellite will be launched to collect data about the earth. Other companies are spending their own money to develop new space launch vehicles.

This is a remarkable development that will greatly benefit the country. First, it helps create national space capabilities without new government expenditures. Second, it

creates private space infrastructure that will help lower the cost of government space missions. Third, it promotes a healthy space industrial base that can also lower the cost of government space missions. Finally, it creates new, high-tech jobs in the aerospace industry that are immune to the vagaries of the U.S. budget cycle.

Despite all these benefits, the commercial space industry is at a very delicate stage of development. Government policies that create an unfriendly business environment or misguided policies that do not take the private sector's needs into account could strangle the industry before it has a chance to flourish. In that case, we will not enjoy the benefits of new privately financed space capabilities and we will not make a successful transition to an earth-space economy. NASA has a crucial role to play in helping create this new industry. It also has the power to inadvertently destroy it by treating new commercial space businesses as traditional government contractors.

Today's hearing will help us understand the rise of this commercial space industry and the roles NASA plays in helping it. NASA is, first and foremost, the largest consumer of civil space technology in the country, if not the world. Yet, its procurement practices suffer from all the problems we find in the world of defense procurement, and which the Department of Defense is trying to fix with its National Security Science and Technology Strategy. Better procurement practices that enable NASA to act as a normal commercial customer in the high-tech marketplace will help promote commercial development and lower NASA's costs. Still, we need to consider new approaches to NASA's work with the private sector. The agency is used to working with large aerospace companies who traditionally define profit in terms of their ability to win government contracts. Yet, the new commercial space companies will earn their profit by providing goods and services to the private sector. Thus, they have different needs from government and the traditional government-contractor procurement relationship will not apply. Our witnesses today will help us define the new relationships that we need in order to bring the earth-space economy to fruition.

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OPENING STATEMENT
by

HON. GEORGE E. BROWN, JR.

November 8, 1995

Good morning. As many of my colleagues are aware, the Science Committee has long promoted the commercial use of space whenever possible and appropriate. In addition, for those activities that are carried out by government, this Committee has sought to ensure that NASA's procurement system is both efficient and fair. I hope that today's hearing will provide some additional insights on both of those topics.

I have been encouraged by the efforts made by NASA over the last several years to strengthen its procurement system. While discussions of procurement often are dry and colorless, procurement represents the indispensable step that transforms visions of future systems and capabilities into realities. It also is the step at which the taxpayers' dollars can be spent wisely and efficiently, or at times, unwisely and inefficiently. An important part of this Committee's oversight responsibility is to ensure that NASA remains an effective steward of the public's funds.

Commercial space activities, on the other hand, are those activities for which the private sector puts its own funds at risk. Government can play a constructive role in promoting space commercialization, and perhaps today's hearing will shed some additional light on which governmental approaches can help the process and which may hinder it.

Nonetheless, I believe that there will continue to be an important role for government to play in the exploration of space and the acquisition of new knowledge. Certainly it is important to leverage the contributions that can be made by the private sector in meeting common public-private goals. However, as testimony at last week's hearing on the Reusable Launch Vehicle program demonstrated, the private sector may be unable or unwilling to assume the entire task of providing the capabilities required by the Nation's civil space program.

Finally, as I have reviewed our experience with space commercialization,

it has become clear to me that the private sector pays a great deal of attention to the stability of the government's commitment (or lack thereof) to the space program. A wavering commitment on the government's part does not create an environment conducive to companies putting significant private capital at risk. If we are really serious about encouraging the commercial development of space, I think that the current effort to significantly and continually cut the NASA budget over the coming five years is exactly the wrong signal to be sending to the private sector. As I have said before and will say again, NASA's activities represent an important national investment--we should be protecting that investment, not cutting it in a counterproductive approach to deficit reduction.

Thank you.

The CHAIRMAN. We will now go to our witnesses, and I think what we will have is the people from the agencies testify first, beginning with Ms. Lee. And then we will go to Mr. Dunn, and then to Mr. Muratore. And then in this order: we'll go to then Mr. Burnett, Mr. Rossi, Mr. Frelk and Mr. Rogers, and try to do it that way.

So, Ms. Lee, I would recognize you first for an opening statement.

STATEMENT OF MS. DEIDRE LEE, ASSOCIATE ADMINISTRATOR FOR PROCUREMENT, NASA, WASHINGTON, DC

Ms. LEE. Thank you very much, Chairman Walker. I appreciate the opportunity to appear before the committee today.

I would like to enter my statement for the record and hopefully summarize that statement here for our abbreviated time.

First, and I particularly would like to thank Mr. Hall for those comments about procurement—we're trying very, very hard—I'd like to set the stage overall for the changes that are happening at NASA. And as many of you have addressed, we know that the American taxpayer, the Congress, the Administration, expect excellence from our space program, and NASA intends to deliver.

We recognize that technical and business excellence go hand in hand, and for many years NASA has been recognized for their technical excellence. But we realize also that we have some significant improvements to be made on the business side of the house, and we are aggressively pursuing that end.

My focus here today is on procurement challenges. But to clearly address that specific area as we talk about procurement per se, generally the procurement procedures are what people talk about or think about when they say "procurement."

But to put that in the right aspect, I have to highlight today the importance of the whole acquisition process and the way NASA is focusing on requirements definition, the up-front activity that starts at any procurement.

As you all know, NASA has undertaken a zero-based review. We've identified core mission and function. We've done strategic alignment. We've taken care of program and center responsibilities. We've done a thorough scrub of support services, which was a traditional way of NASA doing business, and we've made many changes based upon those reviews.

You'll see us changing our mission approach. We've introduced cooperative agreements with for-profit industry. We are talking more about out-sourcing. We're talking about commercialization and privatization in science institutes, and all those things are a fundamental part of the way NASA is changing and evolving.

But there are two primary issues that NASA must continue to address in order to support these changes in the overall acquisition process. And they are: continuing to improve the definition of our needs in results-oriented terms rather than in process-oriented terms. We have not always done that. We have not always done it as well as we could or should and we recognize that that is a key weakness in our system, and we're refocusing at that effort.

But to accompany that we must change our NASA management and oversight structure to compliment the industry role. I know

when John testifies he's going to point out those very issues: how things had to be changed internally; how NASA looked at their requirements and how they proposed to manage them in order to make this change become effective and efficient.

So there is where we're changing up front in our acquisition process. We're going to make—the administrator has highlighted these, I know, in other forums and you're very well familiar with the program management changes and those kinds of things so I won't dwell on them today. I'm going to address the middle part of acquisition, specifically the procurement. After the requirement is identified and defined, how then do we go about acquiring what NASA has determined to be an agency need or requirement?

Over my many years of my procurement career—which are more than I would like to admit at this point—but many, many times people ask me "Why can't you buy like industry? Why can't you just make a commercial buy?" And I think that's a very valid question and I personally have found it an intriguing question. I've struggled with it in my mind to try and articulate what are the basic differences and I've come to use a rather simple equation. I hope you'll bear with me if I kind of briefly go through that.

I can't say that this is good or bad, virtually that it's different. I make a comparison to how I would spend my own money. How Dee Lee spends her money and how I spend the taxpayer's dollars.

I submit to you that there are four basic tenets of procurement and these are kind of the controlling factors or certainly initiate our activities.

The first is responsibility and accountability, a very basic difference. When I go out and spend my own money certainly we hope that I am efficient and effective and frugal, but sometimes I'm not. Nevertheless, there is a difference between when I go out—if I go out today and decide to buy an eight track tape or a Beta recorder you all may chuckle and find it rather amusing and think, "Well, she's not doing the right thing." If I do something like that with the taxpayer's dollars I find myself here in this seat or on the front page of the Washington Post. And that's as it should be. If we're spending the taxpayer's dollars we should have a very high level of accountability and responsibility. I'm not saying that's good or bad but it is different. There's a difference between your personal and your commercial purchases and the government purchases.

The second tenet of procurement, I would submit to you, is our fairness and openness. Now, because we're spending taxpayer dollars it is incumbent upon us to make sure everyone has the opportunity to participate. We don't guarantee contracts. A contractor must earn them. But we do try and make it open for everyone to have that opportunity.

And basically you gave us some additional guidance on that in the 1984 Competition in Contracting Act, which says that full and open competition is the method by which the government procures activities and actions, supplies and services. There are, of course, seven exceptions and I often find myself reminding my technical community that "I didn't plan" or "I forgot" are not reasons for us not to make the competition available to everyone, the large and small businesses, that are interested in participating and perhaps

garnering an opportunity to earn some of the taxpayer dollars by providing a service to the government.

When I go out myself and purchase a car or something like that I do it a little differently. I may survey all of you and say "What did you buy? Are you satisfied? Did you get good customer service? Did you have a good dealer?" Whatever. Then I make a decision. With the government I must go out and advertise nationwide and say "Does anyone want to sell me a car? Here's the basic characteristics that I want to buy." And I must articulate that in a manner that gives you an opportunity to respond to my need and an opportunity to earn that contract. That's the Competition in Contracting Act—good, bad, different. There's a little difference in those two approaches.

The third tenet of government procurement, I would submit to you, are the differences in our socioeconomic provisions.

Again, a government has chosen—and I think we, as a nation, have chosen to have highlighted some issues that are very, very important to us. And as a citizen I applaud that. I like clean air and water. I think that we certainly have established that EEO compliance is important. We have affirmative action for Vietnam veterans. We have the Buy America. We have the labor wage activities. We have lobbying restrictions. We have those kinds of things that are important to us as a nation.

And any time you spend taxpayer dollars on a procurement system you will see the enforcement of those particular activities come back through and perhaps that's where they should be. When we spend taxpayer dollars we expect compliance with those things that we as a nation have said are important. When Dee goes out and buys a car I generally do not ask the dealer "May I see your small and small disadvantaged business plan? Do you comply with jewel bearing certificates? Are you aware of American vessel preference?" Those kinds of things. I don't generally personally enforce societal provisions—good, bad, different. So that makes that a little bit different activity from our commercial buy to how the government buys.

And I submit to you that the fourth tenet or major difference between government procurement and your own personal expenditure process will probably impact us the most. That is the protest process. The fact of the matter is that the government makes mistakes. And when we make mistakes there needs to be a forum whereby interested parties can come in and say, "Wait a minute. You're spending taxpayer dollars. Have you done the right thing? I want the process examined. I want the decision examined." That's our protest forum. And I know you certainly are all familiar because I know there's a lot of bills pending now to do some revision on that.

Again, the difference is when I go out to buy my car—after I've gone out to dealer A, B and C I go to dealer B and I take my product home and I enjoy it. I don't have to park it in the driveway for six months while I wait for a protest resolution of did I make the right decision—good, bad, different.

And I submit to you that that last protest brings me full circle back to accountability and responsibility. Because I am going to be spending taxpayer dollars we're human beings, we know we're

going to be brought forward and have to defend these, most likely, in a protest forum. We tend to make sure that the process is secure, that we got the certification. Maybe we do ask for too much data. Sometimes it does take too long and we are addressing those kinds of issues. But that's the basic foundation behind our procurement system.

As a case in point, on the protest issues over the past five years NASA has had 204 protests before the GAO. Two were sustained. Likewise, we've had 44 protests since 1992 before the GSBCA. We didn't fare as well there. Four were sustained. Then I pulled a few little statistics from our NASA procurement base, and because our protests tend to hit the large dollar activities I just took some snapshots for an example here. Over $5 million for '94 and '95. We really only had 78 and 69 new contracts. Take that against your average, that 55 protests occurred. That's a significant percentage. Many of our actions are being protested. The sustain rate is relatively reasonable.

Now, because of these activities certainly that takes the government more time and effort and I think that's distressing. But the thing that I find most distressing about the procedure is to the contractor who successfully won a procurement and now they have a team of people, they're waiting, they're ready to perform. But they can not perform because they have to wait until resolution of the protest.

So it's a very interesting situation that we have ourselves in. The accountability, the responsibility, the results and the ability to have those reviewed at many times causes us to be risk averse, and I think that's something we're trying very, very hard to overcome.

Having set that stage, what are we at NASA doing to try and improve this? We are doing a lot of things and I'd like to briefly touch on those here.

We recognize that we must have an effective relationship with industry and our first step at trying to improve that is so simple. We recognize we've got to do better communication back to the requirements review. We must provide better statements of work. We must more clearly articulate what it is we want to purchase. We must articulate it in results rather than process and let industry step in and fill that need. We're doing that.

We're focusing on performance based requirements. To that end, how do we further better communicate? Draft RFPs. It sounds so simple but we hadn't always given industry the information early in the process so they could reasonably comment and to make changes. We're doing that. We're providing more draft RFPs in a more timely manner and we're dealing with industry's comments and changing our approach in many, many cases.

We're using a tool we hadn't always used: alternate proposals. We, in the government, I think, many times discouraged them because it was an additional evaluation process for that. We're now encouraging them. Let industry come in and propose an alternate approach as long as they're meeting our end result, our end objective. Let's listen to industry's changes in approach and try to adopt those.

We also instituted an ombudsman. This resulted from industry coming in many times and saying that the NASA procurement

process or acquisition process wasn't as open as it should be. That we weren't accessible. That in some cases we weren't listening. But yet industry felt that dealing on a specific basis or a specific program many times carried some negative responses back with it.

So we've established an ombudsman program where industry can come in on an non-attribution basis and highlight areas or concerns. We've had several submissions to date and in each case industry has been right on. We've made corrections and taken those into account.

Meaningful and timely debriefings to try and approach the protest problem and the delays that that causes all parties involved. I've spent a great deal of time talking to industry and saying, "What is the issue?" In many cases industry has come back and said, "You, NASA, make it a mystery. You make it too much of a guessing game. Tell us why we weren't selected. Tell us what was good, what was bad, what we could do differently."

NASA has really started giving meaningful debriefings. In fact, in one case we had one where I actually had some contractors call me back and say, "Thank you." A not winning offer saying, "Thank you. Your debriefing was so informative that I may be able to use that information in the future." So we've changed that.

We're significantly changing our source selection procedures and those come in two major areas, the small dollar procurements and the large dollar procurements.

And, you know, we've already implemented the midrange procurement process. Thanks to Congressional authorization, we have a pilot program there and we're now conducting some business on the Internet. I've got some very positive feedback from small business and industry alike, particularly small business, that say that the day NASA posts the requirement they can download it, they can read it, they can make a bid/no bid decision in a timely fashion without tying up a lot of resources. They can also respond back to us. We've formed a small team. We award the contract in a more timely manner and we try to make it a succinct, clear contract.

We've gotten a lot of positive feedback from industry on that and we'd like to continue that pilot program, with your support.

Our large dollar procurement—and that's where we have the majority of our protest activities. We have again emphasized our requirements, emphasized results oriented contracting. We've changed our source selection procedures significantly. And we are addressing all proposals when they're appropriate. We're trying to get less data.

We're making more rigorous competitive range determinations. Industry has told me time and time again "If I don't have a chance of winning this procurement don't drag me along. Don't make me spend B&P money. Don't make me keep a team together." So NASA has determined that we must make the competitive range cut true and early and then communicate those findings and results to industry.

We are doing that. We're communicating with industry throughout the process and we're evolving that.

Last: cost control. We, at NASA, have to control our costs. We have budget issues. We have a very challenging time ahead of us

but we can do it. And we can do it when we team with industry and make this happen.

So we are focusing on cost realism in our source selection process. We are clearly communicating to industry what our expectations are. They can certainly propose a high tech solution or a medium tech or a low tech solution but price the solution you propose. We can not, any of us, afford buy ins or those kinds of activities.

So we are making these changes, we're working with industry as we go along and industry has been supportive of this bold step. With the explosion of information technology it's only a matter of time, and I believe it's a very short time, before business is commonly transacted electronically and NASA will be there.

We're leading the government with our mid-range procurements and we're already poised and ready to go commercial on our larger activities, and we're very active in that source but we're following industry's lead. NASA is not going to develop their own unique electronic system. We want to be two steps behind industry. Let industry lead. Industry will figure out the encrypting. They will figure out the security. They will figure out the payment process. And rather than NASA spending taxpayer dollars to develop what we believe should be a commercial activity, we're going to follow behind and take what industry leads and proves to be an effective system.

These are just a few of our many, many initiatives. I think we are clearly moving in the right direction. We want to change our business approach. We want to have an innovative, yet sound business approach. We think that spending the taxpayer's dollars is an awesome responsibility. We're looking at how we can improve the entire acquisition process from definition of requirement and statement of need through the procurement process.

And certainly last, but not least, is more effective management and the appropriate involvement with those things that industry is doing for us, not micromanagement.

I look forward to some results from, of course, some of the bills you have in work—the Cohen bill, the Clinger bill. And we are watching with interest the new FAA proposal and with a little bit of envy because we certainly would like to be doing some of those things.

As we go forward into the future I look forward to enacting these changes and keeping you apprised of how NASA is doing in reforming our entire acquisitions system.

[The prepared statement of Ms. Lee follows:]

Statement Of
Ms. Deidre A. Lee
Associate Administrator for Procurement
National Aeronautics and Space Administration

before the
Committee on Science
U.S. House Representatives

November 8, 1995

I appreciate the opportunity to appear before this Committee today to highlight the many changes and improvements NASA has planned and is implementing to improve our acquisitions.

OVERALL NASA CHANGES

First, I would like to set the stage for the overall changes at NASA. We know that the American taxpayers, the Congress and the Administration expect excellence from our Space and Aeronautics Programs. NASA intends to deliver.

We recognize that technical and business excellence must go hand-in-hand. For many years, NASA has been recognized for technical achievement. We want to expand that to include business excellence and we are aggressively pursuing changes to that end.

My focus today is on the procurement challenges, yet to clearly address that specific area, I must highlight the importance of changing the way NASA looks at and defines requirements -- the very root of a "procurement." The front end of every acquisition, the "requirements" definition process is critical. A "perfect" contract document that does not meet mission needs is of no value, and is in fact, a failure.

NASA has undertaken the Zero Based Review, identifying core NASA mission and functions, their strategic alignment, and the Program and Center responsibilities. Accompanying that review was a thorough scrub of the support services NASA traditionally procured and their role in the overall NASA mission. Basic changes in how we structure business arrangements to accomplish our mission are emerging -- from cooperative agreements with for-profit firms to outsourcing and Science Institutes. Overall, NASA will rely more not just on industry, but on the commercial industry as opposed to traditional Government contractor elements of industry. Yet, to fully invoke the talents of the commercial world, NASA has to continue implementing two fundamental changes.

These are: 1. Improving the definition of our needs --- in results oriented rather than process oriented terms.

2. Changing our NASA management and oversight structure to compliment the industry role.

We expect excellence from our industry partners. As we more clearly define the results needed we are focusing our metrics and management on these end outcomes. How we are going about these significant acquisition changes has been highlighted through other fora and Administrator Goldin has previously testified regarding NASA's program management changes.

Therefore, today, I will address that "middle" portion of our acquisition process, Procurement.

I am frequently asked "Why is Government procurement so difficult? Why don't you just operate like commercial firms?"

This is a valid question, and an intriguing one. As I have grappled with this question during my procurement career, I have developed a simple comparison to help clarify the difference in my mind. I'd like to use that analysis as a discussion point here.

FOUR TENETS OF GOVERNMENT PROCUREMENT

Although simplified for illustration purposes, I submit there are four basic tenets to Government procurement. These are different, although in varying degrees, from the way individuals and commercial firms spend money. None of these approaches can be classified as "Bad" or "Good" rather they are "Different" to suit the circumstances and needs.

The first tenet is that of Responsibility/Accountability. Each of us in our personal lives is responsible for our fiscal behavior. Yet if we don't make an ideal choice, only we bear the responsibility. In a Government environment, the taxpayer bears the cost, which may be substantial. This is and should be unacceptable, as we are the stewards of the taxpayers' dollars. If a mistake is made or judgments vary, a Government official finds herself sitting in this chair before you, or on the front page of the Washington Post. A career can be ruined, a job lost. This is and should be an awesome responsibility. In order to fulfill that responsibility and prevent mistakes people seek additional information and data, they set up structured systems and reviews.

This response is not Good or Bad, but it is different and it is real.

The second tenet is that of Fairness and Openness. The 1984 Competition in Contracting Act requires that Government

procurements be conducted using full and open competition. Because we are spending taxpayer funds, all interested companies must be afforded the opportunity to participate. They must compete and earn the contract but it is incumbent upon the Government to make every effort to fully and openly communicate that opportunity. We in our personal lives also use competition. We rely on the marketplace to develop products and to establish prices. We base our buying decisions on how well vendors communicate to us how they will fulfill our needs. We conduct "best value" analysis considering those factors that are clearly important to us, be they quality, delivery, price or other intrinsic values. The Government decisions are not unlike these. But, instead of relying on information readily available, full and open competition is described as placing a national notice, waiting a prescribed time for responses, evaluating all responses, and fully documenting all considerations and decisions.

This is different. It is important, but it also requires substantial commitment of time and money by all parties involved, including those parties that do not get the contract.

The third tenet is that of socio-economic provisions. The Government bears the responsibility for the good of all. We have chosen as a nation, to emphasize many important social and economic policies. These policies are effected and enforced wherever tax dollars are expended. Hence, they are key elements in Government Procurement. A typical Government solicitation contains an average of 15 certifications and representations, including among others Clean Air and Water Certification, Affirmative Action Compliance, Buy American, Rights in Computer software, Contingent Fee Certification, Labor Wage Statements, Small Business Actions and Procurement Integrity. Special clauses require reporting, assurances, and special systems. In our personal and corporate lives, we rely on businesses to operate in a responsible law-abiding manner. We generally do not personally enforce these societal needs.

Numerous Congresses and Administrations have determined that these are valuable and necessary conditions of doing business with the Government but they do increase costs and make doing business with the Government different. It is incumbent upon our Government to do this. This action does not make the socio-economic provisions good or bad... but it does make Government procurement different.

The final tenet is that of Protests. When you or I make our purchasing choice, we enjoy the results of that product or service. We are not publicly accountable nor must we report and support our decisions to unsuccessful offerors. In Government, we have the unique process by which any interested party may demand a legal review of a selection decision. At that point, all progress usually halts. Generally, performance must be

stayed until the protest is resolved. This is often difficult and costly for the Government, as schedules slip, concurrent actions must be delayed or adjusted and the program costs increase. Even more important however is the impact on the successful contractor, who "won" an award, is prepared to begin performance, often has a team of employees ready to work and now must pay to keep his workforce in readiness to perform the effort whenever the protest is resolved which may take months.

As a point of reference, during the past 5 years, NASA has had 204 protests before the GAO. Of those 2 were sustained. The GSBCA statistics are 44 protests since 1992 with 4 sustained. Government does make mistakes and there must be a method under which interested parties can seek correction of the mistake. This system however, is the most significant difference between Government and personal or industrial procurement. The litigious nature of the Protest procedure bring us full circle back to tenet one: Responsibility-Accountability. The anticipation and preparation for a protest often leads a responsible individual to cautious, risk-averse action that otherwise would not be in the Government's best interest.

Spending of taxpayer funds is no light responsibility and the importance of good, sound business decisions cannot be overemphasized. However, we have led ourselves to over-regulation and a conservative, slow-moving process. There is much hope. The system based upon these tenets can be overhauled and the people are willing to step up to the challenge. Let me tell you about a few of the steps NASA has already taken.

COMMUNICATION

NASA has focused on more effective communications with industry. We are trying to form a more effective partnership - clearly defining each others' responsibilities and expectations. As part of this communication initiative we have embarked on numerous interrelated actions.

Better Statement of Work. As discussed in my introduction, NASA is focusing on better planning and communication of our requirements. This results in clearer understanding of our needs by potential bidders and better proposals by them which result in contracts that more effectively achieve the desired results.

Performance Based Requirements. Additionally, we are, whenever possible, defining our requirements to make them performance based. That is, we are making these requirements results oriented. In the past we in Government frequently laid out very precise detailed instructions on how to accomplish each task. Now we are focussing on telling industry what end product or result we need and giving them the freedom and responsibility to decide how to best meet that need.

Draft RFPs. To support early and interactive industry involvement, NASA is now issuing full draft versions of our solicitations and seeking industry comments for improvements and clarification. Our old practice was to issue limited information, usually describing only the most basic requirements. This did not give industry a complete picture of all the factors they would have to deal with and it certainly did not afford them the opportunity to comment, seek clarification or improve that approach.

Alternate Proposals. Traditionally, the procurement community has not made full use of a tool already available to us -- allowing industry to submit alternate proposals. NASA is expanding use of this option.

Ombudsman. Industry representatives often told me that the NASA acquisition communication channels were not as open as they should be. Industry was hesitant to make comments on restrictive specifications or requests for proposals because of the reaction of the responsible program/procurement community. I believe we are solving that problem. Our people are more open and communicative with industry and more open to industry comments. To further help alleviate the industry concerns, we also implemented an Ombudsman program. At every Center as well as the Headquarters, we now have an individual who accepts and addresses on a non-attribution basis, if requested, any pre-award concerns. Ombudsman can also help firms, especially small business to resolve post award issues before they become major problems. To date we at Headquarters have received several specific queries. Industry had good points and we made changes. The program is working.

Meaningful and timely debriefings. Another industry concern often expressed was that our debriefings after source selection were so limited and restricted that companies protested just to find out why they did not win. After spending a great deal of time and money on preparing a proposal, industry needed and wanted more information on what was positive, what was negative, and particularly what could be improved for the next opportunity. We have revamped our debriefings to provide this kind of thorough, thoughtful, and timely information. I have personally received phone calls from unsuccessful offers, thanking me for the "new" NASA debriefings.

Selection Procedures. Selecting a contractor and awarding the contract were just taking too long, were too cumbersome and too labor intensive for all parties. NASA has again taken numerous specific actions to improve this. Our actions break into two categories.

First, smaller dollar procurements. NASA recognized several years ago that "mid-range" procurements, or those over the small

purchase threshold, but less than $500,000 (now $1 million) just took too long. Often they were as intensive as a multi-million dollar action. NASA developed and implemented the mid-range procurement procedures. They are simplified, basic procedures. The key elements are a small dedicated team of people to evaluate proposals (including someone who has to live with the results), shorter and smaller Requests for Offer, and concise contracts. A major element of this program, thanks to Congressional authorization, was authority in this pilot program to use the Internet versus the Commerce Business Daily for transactions. We are applying lessons learned here to larger procurements, and we are making great progress in our use of the Internet tools. Industry, particularly small business, has been complimentary of this streamlined process.

Next, we are focusing on our large dollar selection process. NASA is completely revising its source selection procedures. We are conducting NASA-wide training on these changes and implementing and improving as we go. Our source selection process incorporates comments from industry and the working level people who have to make the system work. Industry often told us, "If we don't have an opportunity to win, don't string us along. It costs time and money." We have changed that old way of doing business. We are making early and rigorous Competitive Range Determinations. We are using oral proposals where appropriate. In some selections, we clearly tell the offerors that our objective is to have a competitive range cut of no more than three offerors. This accomplishes several objectives -- contractors understand the need to submit good proposals with their initial submittal, and they do; and NASA emphasizes cost realism, not merely a low "buy-in" cost. We are communicating with industry throughout this process.

Cost control. Cost control is vital to NASA. We have given the contractors more responsibility for results. That includes cost control. We focus on cost realism in the source selection. We are structuring our new contracts to more effectively reward successful contractor efforts to control costs; those that aren't successful will lose fee dollars as a result. But that is not enough. We have currently in the public comment process a new Cost Sharing clause, under which contractors who can find better ways to accomplish the desired objective and demonstrate cost savings to NASA sometimes in nontraditional ways can share in those savings. Industry is supportive of this bold step.

With the explosion in information technology, it is only a matter of time (a short time) before business is commonly transacted electronically, much of it on the Internet. NASA will be there. We are leading the government with our mid-range procurements. We are poised and ready to "go commercial" in our large as well as small dollar activities. As quickly as commercial software and process becomes available -- we don't intend to develop Government-unique systems.

These are but a few of our many initiatives. NASA wants a business approach that is innovative, yet sound. We are making great progress. We will make mistakes. We will learn from them and continue to improve. Our challenge is not to let those temporary setbacks lead us back to the risk-averse, regulatory bound procedures.

Thank you for this opportunity. I look forward to keeping your apprised of our progress.

The CHAIRMAN. Thank you, Ms. Lee.

Because this is a focus on NASA procurement we did give Ms. Lee some additional time for her statement. I would ask, though, that the rest of the witnesses limit your time to five minutes so that we do have an opportunity to have some questions here. The schedule of the House is going to be such that we're going to lose our ability to have members be able to ask questions if we don't limit the scope of the testimony here.

Mr. Dunn, if you would testify next.

STATEMENT OF MR. RICK DUNN, ADVANCED RESEARCH PROJECTS AGENCY, ARLINGTON, VA

Mr. DUNN. Thank you for inviting me and thank you for the opportunity to talk to you about some of the things that ARPA has been doing.

Mr. Chairman——

The CHAIRMAN. The text of your entire statement will be included in the record.

Mr. DUNN. Your opening comments address some of the background and history of where we are. It is my view that the current procurement system as it affects research and development is an artifact of the Cold War and does not suit the needs of the current era. And that we in government and industry have not really done a very good job of thinking through the implications of this post-Cold War era.

In addition to that, I am also of the view that in the context of research and development we need to get beyond thinking about buying things. There is a much more dynamic process involved than that and that has led ARPA down the path that we have been following for the past few years.

Let me say a few words about my own background. I first became acquainted with NASA and the procurement system as a summer intern in the Apollo procurement office at the then-Manned Spacecraft Center in 1967. I spent nine and a half years on active duty as a judge advocate in the Air Force and also spent time in the Reserves and National Guard and had many tours where I had responsibilities related to the procurement system.

I spent seven years at NASA headquarters in the Office of General Counsel and while there was involved as counsel to the Space Commercialization Task Force and also in commercializing some expendable launch vehicles. Since 1987 I've been the general counsel at the Advanced Research Projects Agency.

I'd also like to say just a few things about ARPA. ARPA is DOD's corporate research and development agency. It handles matters that cut across service jurisdictions or are too advanced for the services to be involved in. It has a scope that runs from basic research to prototype weapons systems development.

ARPA was originally founded as a space agency before NASA came into existence. Once NASA got up and running it handed some of those responsibilities over to NASA. It became a space agency again in the late '80s, up until about two years ago, and I think it made small launch vehicles and small satellites respectable during that second iteration as a space agency.

ARPA has some statutory authority to enter into non-procurement agreements that I'm going to tell you about today. That statutory authority is directly inspired by and based on certain provisions of the National Aeronautics and Space Act. At various times during its history NASA has exercised Space Act authority in some very innovative and forward thinking ways.

You may be aware that Telstar I, the very first active communications satellite to ever be launched, was a privately owned satellite launched by NASA for AT&T. The government paid no money for the research and development on that satellite even though the technical reports that are in the NASA library look exactly like the kind of technical reports that you would get from a government procurement.

In the 1970's the Delta launch vehicle was upgraded to new capabilities with no government money being involved other than normal oversight.

The satellite users, in partnerships with the vehicle developer, upgraded the vehicle to a new standard.

In the 1980's cooperative endeavor agreements were entered into between NASA and commercial firms whereby shuttle flights were provided and R&D was conducted on the shuttle with private money.

ARPA took this "other transactions" authority, Space Act agreement authority—and it was enacted as 10 USC 2371. We've used it in our R&D efforts and basically we re-invented ourselves. From 1990 to 1993 we entered into 19 other transactions, this was four percent of 471 projects initiated during that period, and the $194 million was 11 percent of $1.82 billion that was executed during that period. From 1994 to the third quarter of fiscal year 1995 we entered into 70 other transactions, 40 percent of our 174 projects initiated during that period and $972 million of $1.2 billion, or 76 percent of our funding. So ARPA is doing its business in a profoundly different way today.

What difference does it make? We are able, because we are exercising non-procurement authority we are viewing what we're doing as not buying stuff but as demonstrating technology, advancing the state of the art, transitioning technology, developing standards, developing industrial capabilities—all of which will have a pay off for the government and which will result in products and services being available. But which in the immediate sense are not just buying stuff, not primarily.

This allows us to step outside the procurement system into basically an unregulated arena and forces us to do business by commercial practices. And commercial practices, as far as I'm concerned, do not involve studying industry and trying to figure out how industry does this or does that. Commercial practices means you sit down at a table and negotiate a transaction on a clean sheet of paper, complete flexibility.

Now, there are a few constraining laws of general applicability—Title VI of the Civil Rights Act. There a few others, but a very few, that constrain the government.

So what difference does it make? The government traditionally has done science and technology development, developed advanced technology and then tried to move them someplace, get them into

a government system or spin them off to the commercial sector. What we try to do is realize that there is no reason to develop any technology unless it's going to go into use.

And oftentimes you want to bring together parties—both the developer, the user or the supplier base—and bring them all together. So most of our other transactions have been consortia agreements. No prime/subcontractor relationship. The parties relate to each other on an equal footing. That has an impact on cost. There is no flow down of burden or cost added to a prime/subcontractor relationship. The federal dollars are flowing in as a conduit directly to the performer.

All of our other transactions are cost shared. Generally 50/50 or even less government funding is involved. The results of this have been we have been able to deal with companies—for example, one of the first agreements we entered into was a single party agreement with Cray Research. Cray Research is a supplier of super computers to the government—to DOD, to NASA and other government agencies. It's the world's largest super computer company, which is not very big because the super computer market is not that big. Cray has never had a government cost reimbursement R&D contract. They have had an ARPA cost share agreement. There's a product on the market today, T3D, as a result of that agreement.

Cray was the world's leader in vector super computing. ARPA was the leader in pushing massively parallel processing. Those two technologies came together as a result of our agreement. Cray has now entered into a second agreement with ARPA.

Cost sharing is very important. Not just because it leverages the government dollars. Cost sharing—the commitment of the private sector companies to actually get something out of the agreement and get a product, to be in business is the rationale for doing away with all those traditional government oversight mechanisms.

How do you maintain the public trust? You make sure you enter into a transaction that everybody has a positive pay off goal. Once you do that you don't need all of the traditional government oversight responsibilities.

I would like to go on and on and tell you about what we've been doing and ARPA but I think I've gotten the basic message across to you.

Thank you.

[The prepared statement of Mr. Dunn follows:]

TESTIMONY

OF

Richard L. Dunn
General Counsel
Advanced Research Projects Agency

Before

The Committee on Science
U.S. House of Representatives

Innovations In Government Contracting Using the Authority to Enter Into "Other Transactions" With Industry

Innovations in Government Contracting Using the Authority to Enter Into "Other Transactions" With Industry

Several weeks ago the Advanced Research Projects Agency (ARPA) of the Department of Defense (DoD) entered into its 100th innovative agreement using the authority of U.S.C. 2371 to enter into "other transactions", that is, contractual arrangements that are neither "procurement contracts", "grants", or "cooperative agreements." The inspiration for ARPA's statutory agreements authority was the provision found in section 203(c)(5) of the National Aeronautics and Space Act authorizing NASA to enter into and perform "other transactions" in carrying out its mission.

The vast majority of ARPA's "other transactions" have been multi-party agreements without traditional prime/sub-contractor relationships typically referred to as consortia or "partnership" agreements. They involve substantial industry cost sharing and usually involve dual-use technologies with both military and commercial applications.

The Cold War drove our Government to become heavily involved in supporting science and technology. Competition with the Soviet Union was played out in both the arenas of national security and national prestige. National security is self evident, national prestige primarily involved the space program and "big science."

Government was viewed as the leader in advanced technology as exemplified by military and space systems. Government viewed itself as <u>the</u> market for advanced technology and thus felt it could set all the rules. An industrial base grew up in response to this view and though it still exists, military and space budget declines since the 1980's have resulted in severe retrenchment.

The Cold War is over and new trends have emerged. The commercial sector often develops technology more advanced than the military and space sectors. Government is clearly no longer <u>the</u> market for advanced technology and is often only a minor player in many market segments. Many high-tech companies refuse to do business under Government mandated rules.

Given the trends of the past ten years it seems obvious that Government should have radically reformed the way it develops R&D to respond to the new realities. Generally speaking, it has not done so. An exception is ARPA.

Because the agreements authority ARPA uses to enter into innovative arrangements is based on the Space Act, ARPA's experience may be relevant to this Committee's consideration of NASA contracting practices. In the early 1980's the Administrator of NASA chartered a Space Commercialization Task Force which studied many of the same questions that are the subject of this hearing. I was the author of a minority report of that Task Force that recommended that NASA adopt innovative contracting methods using the authority of the Space Act. NASA recognizes that it has the requisite legal authority but has been reticent to exercise this authority both then and now.

Before going into this subject in detail, a brief word about ARPA (formerly DARPA) is in order. ARPA is the Defense Department's corporate research and development organization. It addresses issues that cut across Military Department responsibilities or that offer the possibility of revolutionary breakthroughs in military capabilities or affordability. ARPA was originally chartered as a space agency prior to the creation of NASA, but after NASA was created and worked up to operational speed ARPA evolved to the broader mission just mentioned.

Beginning in the early 1960's ARPA began to support advances in computer technology on a broad front rather than focusing on military-specific or command, control and intelligence functions. This approach, which would today be called "dual-use", led to America's dominant global position in information processing systems for commercial and military uses ("America's computer strength came out of DARPA" John Deutch, 1989). There are many other examples. The military pioneered the use of semi-conductors but their cost dropped dramatically when they achieved widespread commercial applications. Advanced materials, advanced display technology and microelectro-mechanical devices are just a few other examples.

ARPA's mission is such that "gee whiz" technology alone is not of interest. Technology that actually gets into use to enhance national security is ARPA's aim. ARPA is not constrained in how this happens, thus dual-use strategies that field technology as commercial products which are available, or can be adapted, for military use are not only legitimate but often considered an optimum approach.

BACKGROUND

Modern Government contracting began at the start of the Cold War era with the enactment of the Armed Services Procurement Act (1947) and the Federal Property and Administrative Services Act (1949). By the early 1950's a separate and permanent defense and

aerospace industry began to emerge. This was caused in part by the needs of a large peacetime military force, and technologies applicable only to military products, but in no small measure it resulted from government contracting rules (such as accounting and audit rules and mandated military specifications) that made a government contractor non-competitive outside the defense marketplace. See e.g., Integrating Civilian and Military Technologies: An Industry Survey (Center for Strategic and International Studies, 1993). "Government contractor" is a better term than defense contractor since the available market includes NASA, FAA, NOAA and other government agencies. Contractors dependent on these agencies may likewise find that business practices mandated by government rules are not optimal for commercial business.

The constraints of the contracting statutes and their implementing regulations (originally DoD's Armed Services Procurement Regulation, later the Defense Acquisition Regulation and Federal Acquisition Regulation) led some agencies to issue "grants" to support university research. Grants were simple instruments not subject to procurement rules. Other agencies, viewing a grant to be a form of contract, believed that the procurement rules applied to grants. Yet other agencies viewed grants as gifts and doubted their authority to give gifts in the absence of express statutory authority. Congress remedied the confusion by enacting the Grant Statute in 1958. This authorized agencies to award grants to universities and non-profit research organizations to conduct basic and applied research. Under the authority of the Grant Statute or other statutory authority some agencies began to award "cooperative agreements" characterized by more active Government involvement than was traditional with grants.

The Federal Grant and Cooperative Agreement Act (1978) was enacted to remedy the substantial inconsistency being practiced by federal agencies in using the various award instruments. Unlike the Grant Statute, which it repealed, the new statute was not limited to research but could also apply to other activities. By repealing the Grant Statute, it repealed that statute's limitations on recipients (university and non-profits) and type of research (basic and applied).

The Office of Management and Budget (OMB), which oversees the Federal Grant and Cooperative Agreement Act, characterized the statute as establishing two categories of transactions -- procurement and assistance, the former being the domain of procurement contracts and the latter authorizing the use of a grant or cooperative agreement. The distinction between a grant and a cooperative agreement is the level of anticipated government involvement. Procurement contracts are to be used when "the principal purpose of the instrument is to acquire ... property or

services for the direct benefit or use of the United States Government... ." Assistance instruments are used when "the principal purpose of the relationship is to transfer a thing of value ... to carry out a public purpose of support or stimulation... ."

In the research and development context this statutory policy has been implemented in the following language:

> Contracts shall be used only when the principal purpose is the acquisition of supplies or services for the direct benefit of the Federal Government. Grants or cooperative agreements should be used when the principal purpose of the transaction is to stimulate or support research and development for another public purpose. Federal Acquisition Regulation (FAR) 35.003 (a).

Despite the repeal of the Grant Statute the Department of Defense, NASA and some other agencies, by policy, until very recently continued to limit grant recipients to universities and non-profit organizations performing basic research. Government-wide regulations governed grants and agreements with universities and non-profits (OMB Circular A-110) but not profit-making companies. Some agencies, such as the Department of Energy, have awarded assistance instruments to profit-making companies, but by regulation applied key provisions of the procurement system such as procurement cost principles and auditing. NASA's notice of proposed rule making (June 27, 1995) concerning cooperative agreements with commercial firms also falls far short of adopting "commercial" practices.

There is a general misunderstanding that procurement and assistance (contracts, grants, and cooperative agreements) cover the field of all possible research and development contractual instruments. The following excerpt is from correspondence between OMB Director McIntyre and the Administrator of the National Aeronautics and Space Administration (NASA):

> On the related question of transactions not covered by the Act, based on earlier comments of NASA and other agencies, a statement has been included in the OMB guidance that transactions such as patent licenses, out-bailments, etc. are not covered by the Act. It would help us in our study if your staff would provide a brief list and description of such transactions...(OMB letter, Oct. 11, 1978).

Over the years NASA has entered into a wide variety of contractual arrangements which it considers outside the procurement and assistance categories. See generally, Dunn, Contractual Mechanisms in Support of Commercial Space Activities

(The Air and Space Lawyer, 1984). Among these is a "funded Space Act Agreement" under NASA's authority "to enter into and perform such contracts, leases, cooperative agreements or other transactions as may be necessary in the conduct of its work..." under section 203(c)(5) of the National Aeronautics and Space Act.

The Comptroller General has held that "authority 'to enter into contracts, grants or other arrangements'...particularly the language 'or other arrangements' is sufficiently broad to encompass transfer of Commission funds so long as the transfer is to an entity carrying out a function set forth" in the agency's statute (B-217093, January 1985).

In 1989 Congress enacted section 251 of public law 101-189 which was codified at 10 U.S.C. 2371. Section (a) stated:

> The Secretary of Defense, in carrying out advanced research projects through the Defense Advanced Research Projects Agency, may enter into cooperative agreements and other transactions with any person, any agency or instrumentality of the United States, any unit of state or local government, any educational institution, and any other entity.

The statute provided for equal cost sharing "to the extent ... practicable ... ." and avoidance of duplication of effort "to the maximum extent practicable ..." Advance payments could be made. Recoupment or other payments to the government were authorized. The authority was to be used only "when the use of standard contracts or grants is not feasible or appropriate ... ."

In 1989 "standard" DoD grants were grants to universities and non-profit research organizations for the conduct of basic research. Standard contracts were described in Part 16 of the FAR and involved the principal purpose of acquiring goods or services for the direct benefit or use of the Federal Government. Much of ARPA's work involves other activities such as advancing the state of the art, demonstrating technology, establishing industrial capabilities, and transitioning technology into actual use. Such activities can be distinguished from simply buying goods and services.

Another characteristic of "standard" DoD instruments in 1989 when the statute was originally enacted is that they were entered into with single parties. The trend toward research joint ventures was in its infancy in the 1980's. The passage of the National Cooperative Research Act of 1984 accelerated the process.

ARPA has repeatedly reported to Congress on its use of "other transactions" authority. Congress has re-enacted the statute three times (1991, 1993 and 1994) making minor changes without changing the substance of the authority. In 1990 (section 244,

Public Law 101-510) Congress authorized a $50 million appropriation for ARPA to fund consortia to support dual-use technologies utilizing the authority of 10 U.S.C. 2371. The following year $60 million was authorized. Each year ARPA used these funds to enter into several "other transactions" which were duly reported to Congress. In 1992 Congress appropriated nearly one-half billion dollars for a series of programs that specifically mentioned 10 U.S.C. 2371 "other transactions" as a funding option. By these actions of re-enacting 10 U.S.C. 2371 and appropriating millions of dollars year after year in the knowledge of ARPA's use and interpretation of 10 U.S.C. 2371 Congress may be viewed as having ratified ARPA's interpretation of its authority. See, e.g., TVA v. Kinzer 142 F. 2d 833, 837 and U.S. v. Two Tracts of Land, 456 F. 2d 264, cert.den. 409 U.S. 887 (1972). In 1993 Congress authorized ARPA to use the authority of 10 U.S.C. 2371 on an experimental basis without cost sharing and whether or not a procurement contract would be otherwise appropriate for strictly military prototype projects (sec. 845, Public Law 103-160).

IMPLICATIONS

ARPA has interpreted 10 U.S.C. 2371 to mean that "other transactions" are a class of transactions outside the procurement and assistance categories as they were implemented by DoD in 1989 at the time of the statute's original enactment. "Other transactions" are not subject to the Armed Services Procurement Act, Federal Acquisition Regulation, Defense Federal Acquisitions Regulation Supplement or other laws and regulations specific to the procurement system, including most of the statutes codified in title 41, U.S. Code. Likewise laws and regulations governing assistance relationships or specific to grants and cooperative agreements are not applicable. Statutes of general applicability such as title VI of the Civil Rights Act of 1964 are applicable.

ARPA has entered into a number of "other transactions" with single commercial firms such as agreements with Gazelle Microcircuits, Cray Research and Intel Corporation. ARPA has entered into unfunded agreements with Rockwell Corporation, Boeing and Northrop. The majority of ARPA's one hundred other transactions have been multi-party agreements, most with multiple signatures and others with one company as an agent signing for all members of a consortium. The agreements are styled in various ways - Coordinated Research Agreement, Technology Development Agreement, or other appropriate designation. The legal authority for the agreement is always expressly stated. Agreements range in total funding from less than $1 million to $370 million. Government funding is almost always less than half and in some cases a small fraction of the total.

TYPES OF RELATIONSHIPS

In its initial report to congress ARPA described the first agreement executed under the authority of 10 U.S.C. 2371. This was an agreement with Gazelle Microcircuits, Inc., a small venture capital supported firm that had never had a government procurement contract. The agreement would accelerate the development of a new class of high speed gallium arsenide communication components. ARPA had previously helped establish the U.S. manufacturing capability for digital gallium arsenide products. The purpose of ARPA's technical and funding support under the agreement was to establish a secure, low-cost, assured source of supply for a key advanced technology for defense needs.

That initial report also provided Congress examples of some of the other types of transactions ARPA expected to enter into:

"(i) Bailment. This would involve the lending or borrowing of equipment typically with a sharing of research or test results.

"(ii) Parallel or coordinated research. This would involve sponsoring a research project that is related to one or more research projects funded by others and involving an arrangement to share results or to coordinate the research so as to enhance the end result of each project.

"(iii) Consortia agreements. This would involve an agreement with multiple parties, when those parties have agreed to join together to perform research as a consortium. The consortium may not be a legal entity with the power to contract. A contractor or grantee/sub-contractor relationship may not be appropriate.

"(iv) Joint funding. This would involve an arrangement with others to finance a third party to conduct research.

"(v) Reimbursable arrangements. This may involve ARPA providing services such as transportation services on an ARPA experimental space launch vehicle, experimental air vehicle, or experimental undersea vehicle. The user would typically provide one or more of its own experiments to be conducted during a test mission. The amount of reimbursement to ARPA could be fixed depending on the extent to which the user's experimental data is to be shared with ARPA and the extent to which it supports an ARPA program."

To date ARPA's "other transactions" have involved one or more aspects from each example except that the reimbursable arrangement involved a satellite ground station rather than a vehicle.

While "other transactions" can be defined in a negative sense -i.e., what they are not, to get a positive feel for other transactions some additional examples may help.

1. Ceramic fibers for gas turbine engines. ARPA (with some

Air Force and NASA support) is co-funding with the seven gas-turbine engine manufacturers work to develop a new class of high temperature ceramic fiber components for gas turbine engines. The actual research work is being done by universities and small R&D firms which are collaborating closely with materials manufacturers.

2. Interferometric SAR commercialization. ARPA contracted with the Environmental Research Institute of Michigan (ERIM) to develop a highly successful airborne Interferometric Synthetic Aperture Radar (IFSAR). The R&D and demonstration efforts are over and no government agency has stepped up to continue to fund the IFSAR operationally. ARPA has an agreement with ERIM to allow the IFSAR to be used in attempt to establish a commercial business distributing IFSAR imagery to commercial and government users. If conditions for a successful commercial transition are met ERIM will transfer the IFSAR to a commercial spin-off company.

3. Advanced composites for bridges. An ARPA sponsored consortium is cost-sharing the development of advanced composite components for bridge construction and repair. One subcontractor is developing production and application techniques to wrap bridge support columns for earthquake protection. Composite cladding will be cheaper than steel cladding now used and will drive down the cost of expensive composite materials for military applications.

EXECUTING "OTHER TRANSACTIONS"

A key distinction between the NASA approach to funded "Space Act Agreements" that I am familiar with and ARPA's approach to "other transactions" is that NASA considers these transactions to be outside its normal contracting process and typically executes them at Headquarters through a program office rather than a contracting office. ARPA has fully integrated "other transactions" into its routine way of doing business through its Contract Management Office. A single competitive solicitation may result in multiple types of instruments being awarded, for example, a mixture of procurement contracts, grants, or "other transactions" depending on the proposals received. In other cases proposals are specifically sought that will result in "other transaction" agreements being awarded.

"Other transactions" are one more arrow in the quiver, so to speak. They are highly valued. They often fit ARPA's needs but they are not the sole way to do business.

Negotiating an "other transaction" requires a team effort of technical program managers and contracting officers with some legal support. A clear common understanding or "vision" of the project is essential and typically is negotiated first. With a

clear vision and substantive pay-off for both the military and commercial interests, negotiation usually proceeds smoothly.

COMMERCIAL PRACTICE

Since "other transactions" are not subject to the rules applicable to government contracts and assistance relationships, ARPA is able to enter into agreements based on commercial practices. The essence of "commercial practice" is the ability to negotiate terms and conditions unconstrained by pre-ordained rules and forms. This has enabled ARPA to enter into agreements with companies who refuse or are unable to enter into government cost-reimbursement research and development contracts. ARPA has been able to enter into agreements with small venture capital supported companies like Gazelle; the leading super-computer company, Cray Research, which has never had a government R&D procurement contract; and industry giants such as Hewlett Packard and Intel. ARPA has entered into agreements with divisions of IBM that do not typically do business with the government. Rather than imposing government cost accounting and auditing practices on these companies, ARPA makes payments based on achievement of technical milestones and accepts commercial audits based on generally accepted accounting principles. The dozens of clauses that are required in a government procurement contract as well as pages of representations and certifications are not found in "other transactions". ARPA's "reps and certs" take up one page.

Rather than rules and regulations, ARPA's agreement negotiators have to rely on common sense and good judgment to craft an agreement that achieves government objectives collaboratively with industry and maintains the public trust. ARPA often accedes to industry demands for provisions not usually found in government procurement contracts but only after due diligence; i.e., a full disclosure of relevant facts and a well developed rationale for industry's position.

INTELLECTUAL PROPERTY

The Bayh-Dole Act (1980) provided a uniform and enlightened policy on allocation of patent rights to universities and small businesses receiving government support to conduct research. In 1983 a Presidential Memorandum extended the policy of the Act to large businesses as well.

The Act allows performers to retain title to inventions conceived or first actually reduced to practice with government funding. The government retains a paid-up license to use the invention for government purposes which includes competitive procurement. The government also retains march-in rights, which

allow it to license the invention for commercial purposes if the title-holder fails to take reasonable steps to achieve practical application or other specified conditions occur. There are various administrative requirements related to invention disclosure and election to retain title to the invention (i.e., file a patent application). The import of these administrative requirements is that the invention can be maintained as a trade secret for a relatively modest period before a patent application must be filed or title reverts to the government.

The scheme of the Act was both to promote commercial use of inventions made with government support and to give the government certain rights. The Act has been successful to a degree. However, it failed to accommodate a number of trends that emerged after 1980. These include R&D joint ventures involving government contractors and commercial firms; commercially available technology advancing faster than government supported technology; the end of the Cold War, the shrinking defense market and the need of government-contractors to become more "commercial." In instances where the government wants to enter into R&D relationships with commercial firms or where government contractors want to diversify into civilian product lines the Bayh-Dole allocation of patent rights is no longer adequate in all cases.

The Bayh-Dole Act comes into play when the research is conducted under a government "funding agreement," which is further defined in the statute to be a "contract, grant, or cooperative agreement ... ." Congress has endorsed the view that ARPA's "other transactions" fall outside the scope of the Bayh-Dole Act.

The conference report of the House and Senate Armed Services Committees on the National Defense Authorization Act for Fiscal Year 1992 stated:

> The conferees also recognize that the regulations applicable to the allocation of patent and data rights under the procurement statutes may not be appropriate to partnership arrangements in certain cases. The conferees believe that the option to support "partnerships" pursuant to section 2371 of title 10, United States Code, provides adequate flexibility for the Defense Department and other partnership participants to agree to allocations of intellectual property rights in a manner that will meet the needs of all parties involved in a transaction. (Senate Report 102-311, p. 576)

In 1994 the House Armed Services Committee report on the National Defense Authorization bill noted that ARPA policy for "partnership" programs was "to negotiate intellectual property rights in 'partnerships' so as to optimize the chances of

successful commercialization." Further, ARPA "policy provides that the Federal Government should avoid acquiring rights if that will impede commercialization. Foreign access to technology is scrutinized and, if deemed necessary, restricted. Broad exposure of the technology among partnerships participants is encouraged."

> The Advanced Research Projects Agency (ARPA) can fully effectuate these policies because it has great flexibility to tailor patent and other intellectual property rights provisions under its "other transactions" authority. (House Report 103-499, p. 285)

Seldom does ARPA abandon the general scheme of the Bayh-Dole Act. ARPA requires its industrial partners to make the case that the standard patent clause is inconsistent with the goal of a particular project. Typical ARPA concessions are to delay the effective date of the government purpose license for a period of years and to specifically define what are reasonable efforts toward practical application that will preclude exercise of the government's march-in rights. Through such measures ARPA can reduce the actual and perceived risk to the partnership during the initial phase of a project.

The allocation of intellectual property rights also involves a balancing of the relative needs and prior investments of the parties. If industry has advanced the state of the art through the expenditure of large sums of capital over many years with little or no government support, the government should be more open to industry's request to maintain a proprietary position especially if the Government's interests are primarily served by having a product available in the marketplace.

The goals of the particular project often define the optimum allocation of rights. For example, ARPA has entered into agreements where one result of the effort is for the partnership to develop a proprietary version of the first generation of a new product while also developing the industry standards or reference architecture for future generations. The standards are delivered with unlimited rights since their very purpose is to be publically available.

In the area of sensitive business and technical data, ARPA typically minimizes the actual delivery to the government. Data which becomes an "agency record" for purposes of the Freedom of Information Act runs the risk of being disclosed to a competitor or, at the minimum, requires a commercial firm to spend time and expense convincing the Government that the record should not be disclosed to a requestor. In lieu of delivery of sensitive data, alternative methods of keeping the ARPA program manager and agreement administrator informed are used such as meetings, briefings and delivery of summary reports.

OTHER OBSERVATIONS

Although most of ARPA's other transactions have been multi-party arrangements, this is clearly not the only, or in some cases even an optimum, way to do business. While consortia offer many advantages such as pooling talent, leveraging investments and developing strategic relationships, not every project or technology development can be accomplished collaboratively. ARPA's experience has been that working out the proper roles and relationships among the industry partners is often more difficult and time consuming than working out the Government-industry relationship. Without the flexibility of "other transactions" it would probably be impossible to reach agreement in many cases.

Foreign participation in ARPA sponsored efforts presents challenges and opportunities. The best technology is often not available domestically. Refusing to work with foreign companies would be a case of shooting one's own foot. On the other hand in this post-Cold War era domestic economic strength must be carefully considered in government mission-oriented research and development. ARPA has developed a "Foreign Access to Technology" clause which it includes in its agreements. Companies with plans for strictly domestic production generally have no problems with the clause. In the case of multi-national companies and partnerships involving foreign firms, the clause generates elucidating discussions which help ARPA to understand where the economic benefit of the project is likely to go. ARPA tries to accommodate industry's needs so long as the end result is substantial benefit flowing to the U.S economy and the likelihood of assured access to the technology.

Cost-shared partnerships provide a real opportunity for developing new, less adversarial government-industry relationships. Each project is dual-use in nature and industry has a strong incentive to push the project to a successful conclusion. It is industry self-interest, rather than government oversight, that becomes the dominant feature in maintaining the public trust. Each participant has a strong interest in performing as effectively as possible. Additional pressure comes from the industry partners who are typically dependent on the success of every other participant.

Use of fixed price payments triggered by the accomplishment of technical milestones reduces the need for extensive financial reporting and audit. This also avoids imposition of government cost principles and accounting systems which are anathema to many commercial firms.

Operating in a partnership environment is not natural for government or industry. Many traditional attitudes do not work

well. In fact the stock in trade of the legal profession - focusing on avoiding failure and leaving nothing to trust - is particularly ill-suited to developing fruitful partnership relations. Few rules are applicable to "other transactions." This makes many people in both government and industry uncomfortable. For those willing to accept the challenge, however, working in such an environment is particularly rewarding.

CONCLUSION

At a time when government is trying to reinvent itself and Government's role in research and development is being re-examined in light of the end of the Cold War, the authority to enter into "other transactions" provides government agencies an unparalleled opportunity to experiment with new ways of doing business. "Other transactions" permit the deregulation of government supported research and development. Government is able to enter into "partnership" with industry and leverage not only the resources but also the genius and leadership of industry to the mutual advantage of both Government and industry. Government is no longer the market for high technology. Government technology developments must not only meet mission needs but must do so affordably. The dual-use strategy is premised on the view that integration of the Government market into the broader commercial market place is an important facet in assuring the affordability of high technology products for the military. "Other transactions" that are extremely flexible and permit the adoption of commercial practices can be an important tool in reaching the goal of affordable military superiority for the United States. They should be able to help civilian technology agencies meet their goals as well.

The CHAIRMAN. Mr. Muratore.

STATEMENT OF MR. JOHN MURATORE, LYNDON B. JONSON SPACE CENTER, HOUSTON, TX

Mr. MURATORE. Mr. Chairman, members of the committee, I'd like to enter my statement for the record and summarize my comments for the committee.

It's a pleasure to be able to speak to you today about the Mission Control Center at the Johnson Space Center and the progress we've been making there.

The new Control Center is now operational. We've used it for the last four shuttle missions extremely successfully. One of the old control rooms at Johnson was shut down over a year ago and the second and remaining old control room will be shut down in the February time frame. We were able to go from basically the bare floor to the new Control Center in less than 18 months.

The total cost of the new Control Center when we finish it up here in the next year or two is going to be $75 million less than the original estimate of $325 million, between a fifth and a quarter of the cost reduced out of the program. That was due largely to the switch from custom designed equipment to commercial, off the shelf equipment and software. In doing this we brought in a lot of non-traditional vendors, both in computer hardware and software. We have the world's largest local area network in the facility. It has over 200 computers on it from 10 different manufacturers and all sorts of various software vendors in the facility.

Not only did we reduce the cost to develop the facility by using commercial, off the shelf equipment, we significantly reduced the cost to operate the facility. This year the facility is operating at $10 million a year less than the cost to operate the facility in '93. And by '98 we expect to be able to run both the shuttle and the station programs out of the new Mission Control Center for two-thirds the cost that it took to run just the shuttle program out of the old Control Center in '93.

That says we're going to be able to run two programs for two-thirds the cost of the old facility. To me that says if we can re-engineer NASA with this sort of approach what we can do is take on new challenges for very small amounts of additional dollars.

I'd like to think when you add up all those savings in terms of the big development reductions we got from using commercial, off the shelf equipment and the big operations costs savings that we funded basically another research program, another science program that we can do at NASA.

All this was accomplished by a switch from custom design to commercial off the shelf hardware and software. We use all the computer equipment out of the box. We don't modify it at all. To do this we had to become very smart buyers. We couldn't just sit in the abstract, only having had experience with custom systems, and write specifications and expect to get anything back but custom systems. So what we did was we did a lot of small scale projects, hands on with the civil servants and we used those to get a better definition of requirements. And I'm going to echo Ms. Lee's comments. The key to doing better work with the commercial marketplace is to really understand your requirements. And under-

standing your requirements doesn't mean just understanding how you used to do it. It means understanding how it can be done with the new equipment and the new technologies.

So we're becoming smart buyers. We were able to maximize the competition. In particular, a lot of the marketplace in computer hardware and software is cutthroat, competitive. And what we did was when we became smart enough about how we could do things with the new technology we were able to open up the procurements to basically the entire industry and we were able to get dramatic cost savings. Literally, the computer work stations—there are over 150 of them in the facility. We got them for less than 50 percent of the cost that you'd get them on the marketplace, and we were able to get five years of continuing maintenance on the devices as part of that price. And that gives us big operations cost savings, because we don't have to maintain the devices any more. We let industry do it.

Smart buyers can also make proper system engineering decisions to take maximum advantage of commercial hardware and software. By being smart about what we can do with the technology, we were able to go ahead and reduce the total amount of unique software to run the basic facility from four million lines of code down to two million lines of code. Industry maintains all the rest of it. We just use commercial out of the box software. Racks of equipment were similarly reduced from 1,400 racks of equipment for the shuttle to less than 700 racks of equipment for the shuttle and station.

In doing all this we changed the way we do business. We were able to reduce 75 percent of the paperwork associated with the production of the new Mission Control Center. We literally went through all of the documentation and cut out 75 percent of the contractually required documentation. That allowed us to move a lot faster and we haven't seen any problem associated with reduction of that sort of paperwork.

We based the design of the whole Control Center to reduce the cost of the Control Center to NASA, and that was our main motivation for doing it. But as it turns out, what we were doing was we were first reaping the harvest of the investment NASA made in computing and software in the '60s. As late as 1963 over 90 percent of the integrated circuits produced in the United States were consumed by both NASA and the Air Force because only NASA and the Air Force had the unique requirements for low power, small size and low weight.

When we made the investment in the Control Center we thought we were just trying to save ourselves money but what we also did was made an investment in the kinds of technologies that America is going to need in the next decade when we link large numbers of computers together to perform critical applications in telecommunications and medical services, in transportation.

And because we worked with the commercial vendors we didn't develop it in a private environment. The lessons that we learned, the problems that we fixed in this system are already out on the marketplace. We worked with our vendors to develop solutions to the problems of making this kind of large scale distributed computer system and those improvements, the products are already out on the marketplace.

Over all, this has resulted in a new Mission Control Center that has better capabilities, that's going to allow for safer flight because it gives us a better view into the spacecraft. The software, because we're able to focus only on those parts associated with the space mission, are of higher quality. In fact, higher than industry quality standards. And I think that the new Mission Control Center proves that by re-engineering NASA we can reduce the cost of doing business, take on world class challenges, do it fast and produce some very high quality products.

Thank you for the opportunity to talk to you today.

[The prepared statement of Mr. Muratore follows:]

Statement of
John F. Muratore
Associate Director, Engineering
Lyndon B. Johnson Space Center
National Aeronautics and Space Administration

before the
Committee on Science
U.S. House of Representatives

November 8, 1995

Mr Chairman and members of the Subcommittee:

I am pleased and honored to be able to present a statement on the development of the new Mission Control Center for Space Shuttle and Space Station at the Johnson Space Center.

The new Mission Control Center (MCC) at the Johnson Space Center is proof that NASA can execute projects of world class complexity on schedule and for significantly reduced costs. Delivered in eighteen months at a development cost reduced by tens of millions of dollars from the original estimate, the new MCC provides NASA the capability to control Space Shuttle, Space Station and other space projects with a common, modular, modern computer and communications architecture.

The new MCC will allow JSC's Mission Operations Directorate to operate both the control center operations for Space Shuttle and Space Station in 1998 for 2/3 of the yearly costs that it took to operate the old MCC for Space Shuttle alone in 1993. We will be able to provide MCC facilities for two programs at less than the cost of the original operating capability for one program. I believe that this is proof that by re-engineering NASA, we can take on new challenges for small increments of cost.

The new MCC was developed using an approach based on Commercial Off the Shelf (COTS) hardware and software. This meant that instead of developing custom equipment or heavily modifying computer equipment, we used computer equipment straight out of the box. This was a major step by NASA and a big piece of the development cost reduction.

In order for NASA to transition from a custom design approach to a COTS based approach, NASA demonstrated the capability of the technologies in small scale by projects with civil servants performing the "hands-on" work. This developed the skills and knowledge of the NASA civil servants so that they could be "smart buyers". Much of this small project work was funded by the advanced development

and technology functions within NASA and was enthusiastically supported by JSC and Mission Operations Directorate management. As "smart buyers" we were able to specify procurements to allow the widest possible competition. This resulted in major cost reductions, essentially reducing the cost of the major computing components by 50%. The vendors were also required in these procurements to include extended maintenance of the computer equipment. This significantly reduced the yearly operations cost of the MCC because we did not have to develop the skills within NASA to maintain this commercial equipment.

Being "smart buyers" also meant being sufficiently experienced in the hardware and software available in the marketplace to architect the new MCC so that it could take maximum advantage of commercially available software. Because we could rely on the private sector to maintain the commercial software, we were again able to significantly reduce the annual operating cost of the new MCC. We were able to reduce the code maintained by NASA from over 4 million lines of code to 2 million lines of code.

Building the new MCC based on commercial standards allows NASA to use new developments in the computer hardware and software industry as soon as they are available. As the vendors plan their upgrade paths for their commercial customers, they also provide an automatic upgrade path for NASA. We essentially allow NASA to utilize the entire commercial marketplace as the research and development environment for the computer components for the next generation of the MCC.

As we based our design for the new MCC on the modern computer and software industry, NASA was taking advantage of the NASA investment in these fields in the 1960's. As late as 1963, over 90% of all of the integrated circuits produced in the United States were bought by NASA and the United States Air Force for space and missile programs. Only these programs had requirements for small size, low power and lightweight electronics and could bear the high initial development costs for these components. This investment helped the fledgling industry reduce the costs to produce integrated circuits. It was not just a coincidence that the first modern electronic handheld calculators came on the market just as the Apollo lunar landings were happening. The investment made by NASA and USAF in the 60's helped to bring about a technology that is in every personal computer, cellular phone, fax machine, microwave oven and automobile engine. This investment not only enabled the development of the modern electronics hardware industry, but also a billion dollar/year software industry.

As we developed the new MCC using COTS hardware and software, we initially intended only to reduce NASA costs. We were reaping the harvest of seeds planted by NASA in the 60's. As the new MCC developed however, we began to realize that we were making an investment in a new technology, the technology of linking together hundreds of computers in a critical function. In doing so, we were planting seeds for industries of the next decade.

The new MCC is the largest Fiber Data Distributed Interface (FDDI) Local Area Network in the world linking over 200 computers from 10 different manufacturers on 150,000 feet of fiber optic cable. Although all of the components we bought were commercially available, they had never been put together on this scale before in a critical application. The new MCC also links video, audio, text, graphics and real time control and monitoring information. Integration of all of these types of data in a large scale critical application based on commercial equipment had never been attempted before.

This type of large distributed computer system in critical applications is the kind of computer system that will be dominant in industry and government in the next decade. But private industry could never afford a facility like this to test their products. The new MCC became a "final examination" for industry to find problems in applying their products to this type of problem. By partnering with industry, we were able to find and fix problems together, improving both the MCC and the industry's product lines. Problems in the fields of network management, computer security, software management and remote diagnostics and maintenance were solved and the solutions put into the marketplace by our vendors.

An example can serve to explain the kind of technology we were developing with industry in the new MCC. The pre-release product testing of a commercial computer would not normally find a "bug" if it occurred very rarely. For example if such a "bug" required a unique set of circumstances that statistically might only occur once every 100,000 hours of operation, it would be very hard for a product manufacturer to find it prior to releasing a product. The manufacturer couldn't afford to test the product enough to see the bug once, much less the two or three times necessary to isolate and fix the problem. If a critical operation, such as controlling an industrial plant or a piece of medical equipment, only required one of these computers, a latent rare bug of this probability wouldn't be seen in 11 years of operation, probably longer than the lifetime of the computer. A computer with this type of rare bug, even if the bug had serious implications, would be considered very reliable for single computer applications.

However when you combine 200 of these computers, as we did in the new MCC, and use these computers 24 hours a day, as we do in controlling space shuttle and will do for the space station, a rare bug of this magnitude could be expected to surface once every 20 days. If this bug had serious implications for the system, such as causing the local area network to fail, a computer system containing such a rare bug would be unacceptable in the demanding environment of human space operations. Working with industry, we developed techniques in the new MCC to isolate and eliminate these types of rare bugs from their products. This resulted in an overall improvement in these product's ability to support the demands of the next decade in critical applications such as industrial process control, air traffic control, telecommunications, defense and medical industries.

It was an honor to be involved with the development of this new facility. I hope that it provides proof that NASA can work better, faster and cheaper and will give you confidence to invest in us to take on further challenges in the future. Thank you for the opportunity to speak to you today.

The CHAIRMAN. Thank you.
Mr. Burnett.

STATEMENT OF MR. DENNIS BURNETT, COUNSEL, ON BEHALF OF MR. JOHN CASSANTO, PRESIDENT, INSTRUMENTATION TECHNOLOGY ASSOCIATES, INC., EXTON, PA

Mr. BURNETT. Thank you, Mr. Chairman, members of the committee. Thank you for allowing us to appear today with you. Please include my remarks in the record.

The CHAIRMAN. Without objection.

Mr. BURNETT. I'll proceed in a summary fashion.

I'm appearing here today in place of Mr. John Cassanto, the president of ITA. John has been ill and would love to have been here. He is on the mend and I'm sure you'll see him again very soon.

The CHAIRMAN. Good.

Mr. BURNETT. As you probably know, I'm an attorney. I do a lot of work for a variety of clients in a mixture of commercial space applications. I've been associated with ITA for some time. John asked me to sit in for him today.

ITA has had a long relationship with NASA. It's an interesting story and I'd like to tell you a little bit of that story today and share some of the lessons I think that we've learned from that relationship.

The story really centers around this device right here, and I think some of you have already seen this. This is the materials disbursion apparatus right here. And if you'd like to see it I'll be happy to bring it up and you can look at it later.

This particular flight unit was actually flown on STS-67. There are four of these in this containment vessel here and this flew on STS-69. And we'll talk a little bit more about what happened on those flights in a little bit here.

By the way, that's the device which holds the experiments and it also has a control device, which is this, and it's attached to it by a small wire with very simple controls. It is not a bomb, by the way.

In the mid-80's John Cassanto and others thought that there was a way to grow protein crystals in a microgravity environment using a technique that was not being pursued by NASA. NASA at that time, at least in the microgravity area, looking at a technology called vapor diffusion. John and others felt that there was another way to go about this. That was to use liquid liquid diffusion. Therefore, he saw a market opportunity to build the MDA, the materials disbursion apparatus, and he went about raising the money, the capital to go forward on his own.

With the help of a lot of people and some government grants from the state of Pennsylvania he went ahead and built it. He then came to NASA and asked them for help in developing the market. This proposal was consistent with some of the policies that were being carried out by NASA at the time. He was asking for what was called then an SSDA. These agreements change acronyms from time to time but essentially it was an agreement to share in the development of a new device on a non-exchange of funds basis.

Now, that proposal went forward in about 1988 with the materials disbursion apparatus and they quickly reached agreement on in MOU. But the final agreement took a long, long time to negotiate. There were many, many problems faced by NASA in coming to a final agreement. Some of these problems had to do with the use of the space shuttle, in particular that there was no pricing apparatus or policy for the mid-deck lockers. There were other policy issues involved as well.

To make a long story short, finally in 1991, with the help of this committee and others, NASA and ITA finally came to an agreement on a fairly unique arrangement called the CMIX, which is essentially a barter arrangement. And the arrangement is in this chart which I have up here.

For those of you who can't see the chart at the end of appendix II there's a copy of it. This is what it looks like. It just describes in summary detail what this barter arrangement is.

Essentially what it was was that John was allowed to fly his equipment and NASA would have access to the use of 50 percent of the capacity and he would have the ability to go out and market his 50 percent to commercial and scientific users out in the marketplace.

This program has had four shuttle flights. There's another flight to be flown shown here in November of 1996. The program has proven to be very successful. It has a number of developments—biomedical, anti-cancer drug research. They have a microencapsulation project. They have a Urokinase protein crystal growth project which hopefully will result in some steps forward in the treatment of breast cancer.

They've had good results in dealing with international customers. And John, on his own nickel, has developed an education program involving seven states and 12 different schools who are participating. They're allowed to fly experiments on the MDA. And I think it's a very good project that he's done. He's not getting a nickel out of it but he tells me that some students have changed their careers and have decided to pursue space science as a result of it. These are the kinds of things I think we should be encouraging.

Of course, this whole program is not geared just to flying on the shuttle. The shuttle has a maximum duration, as you know. The ultimate goal is to fly these kinds of equipment on the space station where we've got a microgravity environment, where you can have long term experiments and hopefully have much better results. The results have been promising but of course there have been no breakthroughs, but that's the nature of this kind of developmental program.

If we look at the next chart you can see that ITA has plans to upgrade the equipment to allow larger volume of fluid to be flown, to allow a greater sample of data. They now fly about 400 data points at a time and they will increase that to about a thousand. They've also put a video capability in the device so that you can actually see what's going on and view the results. And, of course, they intend to adopt it all for the space station ultimately.

Unfortunately, everything hasn't gone perfectly in this program. In the first and the third missions there were some errors made which resulted in some of the experiments losing the results—

about 50 percent of the experiments were failed because of that. And as a result, ITA has requested NASA for some reflights for those so they can complete their experimental program. NASA has balked at the idea of reflights and instead has said that they would prefer to enter into a new kind of agreement extending two additional flights but reorienting the program. This is perhaps a very good idea. We don't know quite yet. There's some disadvantages to this approach. They want to abandon the barter arrangement and focus on a product oriented arrangement. There are some disadvantages to this and we'll just have to see how the negotiations work out. I'd say it's very promising, however, and NASA is working very hard with ITA to come to some acceptable arrangement.

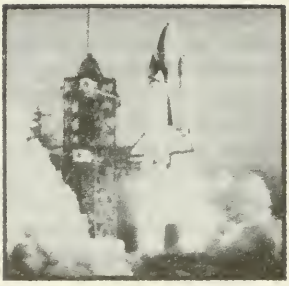
We also learned—or at least I have learned only in the last few days I think a very unfortunate thing. It sounds like a very unfortunate thing. We've learned that NASA is developing a device which appears to replicate the functions of what John has already done. We're at a loss to understand why they're spending the money to do that. We think it's unnecessary. We need to look into this further because, as I said, I first learned of this yesterday. I think we need to look into it and I encourage you to look into it too.

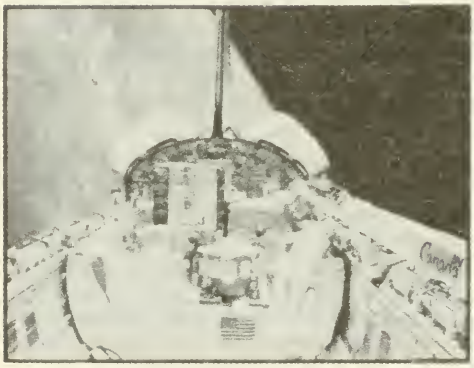
Now, if we can turn to our lessons learned. I think the lessons learned from this——

The CHAIRMAN. I would remind you that your buzzer went off here about five minutes ago. I would like to try to hold this down.

Mr. BURNETT. I will refer to my lessons learned in my statement and just say at the end then, in summary, that real support for commercial activities by this committee will make a real difference and big rewards to the United States. We encourage you to review the recommendations which we've made, and I'll be happy to answer questions.

[The prepared statement of Mr. Cassanto follows:]





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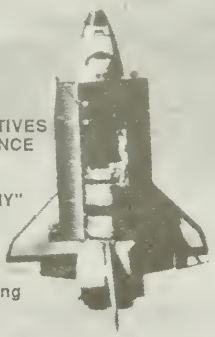
TESTIMONY
OF JOHN M. CASSANTO
PRESENTED TO THE
U.S. HOUSE OF REPRESENTATIVES
HOUSE COMMITTEE ON SCIENCE
REGARDING
"NASA PURCHASING IN
THE EARTH-SPACE ECONOMY"



November 8, 1995
Rayburn House Office Building
Washington, D.C.

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U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE

Testimony of

John M. Cassanto
Instrumentation Technology Associates, Inc.
Exton, Pennsylvania

Presented by

Dennis James Burnett
PIERSON, BURNETT & HANLEY
Attorneys for Instrumentation Technology Associates, Inc.

(November 8, 1995)

Mr. Chairman and distinguished members of the Committee:

Thank you for the opportunity to appear before the Committee and share our views about NASA contracting and procurement from commercial space enterprises. Although Chairman Walker and Mr. Hall are familiar with Instrumentation Technology Associates, Inc. ("ITA"), some Members of the Committee may not know who ITA is. Therefore, I will begin with a brief introduction of the company, a description of how ITA has developed and a summary of its relationship with NASA.

I. BACKGROUND

ITA was formed by John M. Cassanto in 1982 to develop commercial space hardware, in particular hardware for use in microgravity experimentation and commercial production and re-entry capsules. Located in Exton, Pennsylvania, ITA was founded and has been sustained by commercial investors, commercial lenders, and the State of Pennsylvania which provided grants--all who had faith in the future of commercial space. John Cassanto, President and chief visionary, is an aerospace engineer who cut his teeth on the design and development of re-entry vehicles for strategic and tactical protection of the United States during the height of the cold war.

Space microgravity infrastructure is ITA's market niche. ITA manufactures standardized experiment modules that can be integrated easily into available transport such as the Space Shuttle middeck, sounding rockets, re-entry vehicles and research aircraft. ITA has an established expertise in low gravity research and the engineering services necessary for turn-key microgravity services. ITA has developed customers in the United States as well as international clientele in Canada, Europe, China and Japan. ITA also has formed strategic alliances with companies in Germany and Russia which broaden its product and service base as well as provide access to the global marketplace.

ITA was founded in large part due to U.S. government policies encouraging private/public sector cooperation in supporting the commercial development of space. With their focus on NASA's role as joint partner with the commercial space sector, these policies emphasized three fundamental themes:

- The government would provide an environment conducive to private sector investment in space;
- The government would purchase goods and services from the private sector involved in commercial space activity in order to stimulate the industry; and
- The government should enter into cooperative /collaborative agreements for research, such as Joint Endeavor Agreements ("JEAs") for Shuttle flights for the private sector entity wishing to fly experiments or to have development flights of space hardware that would ultimately be used in commercial space ventures.

One of ITA's first projects was the development, in 1983-84, of an ITA Standardized Experiment Module ("ISEM") for users of NASA's Get Away Special Shuttle Program. Subsequently, ITA decided to pursue a JEA with NASA for a Shuttle bay carrier that would have been a significant upgrade of the ISEM. It took 18 months from the date of the formal submittal of the JEA proposal to negotiate and sign the JEA Agreement. By way of comparison, it took NASA three months to negotiate and sign the first Space Station agreement with the Russian Space Agency. Unfortunately the ISEM JEA met an untimely demise when the Challenger went down on that tragic January morning in 1986.

ITA changed its direction after Challenger to pursue the development and manufacture of material processing space hardware that would be generic, multi-purpose, multi-user and provide a high density of data so that the cost per data point could be drastically reduced. The manufacture of the Materials Dispersion Apparatus ("MDA") was the result of ITA's reorientation. By 1988, the MDA had been developed and manufactured with private funds and ITA was ready to demonstrate the operation of the device. Further information about the MDA is provided in Appendix 1.

ITA approached NASA with a proposal to enter into a Space Service Development Agreement ("SSDA"), a type of agreement which had become the successor to the JEA. In 1988 NASA and ITA signed an MOU agreeing to enter into a SSDA that would allow ITA to fly the MDA in a Shuttle mid-deck locker. A formal proposal and draft SSDA was submitted to NASA in December of that year. What ITA didn't know and couldn't possibly have fathomed was that NASA would never come to terms on the SSDA and that ITA would nearly expire in the pursuit of the SSDA agreement.

Fortunately, ITA also decided to work with the Consortium for Material Development in Space (part of NASA's Centers for Commercial Development of Space (or "CCDS")) at the University of Alabama in Huntsville to fly the MDA on the Consort sounding rocket which was then being developed. The MDA first flew on Consort 1 in March of 1989 and proved to be a success. ITA continued to fly the MDA on Consort launches over the next several years.

In the meantime, there was no progress on the SSDA with NASA. In an effort to get the MDA qualified for the Shuttle, ITA joined another NASA CCDS. ITA prepared and completed the extensive Shuttle documentation and testing to qualify as a CCDS sponsored payload on the Shuttle. ITA successfully flew four MDA's on Space Shuttle flight STS-37 in April of 1991. The Payload Specialist on that mission, Mr. Jay Apt, enthusiastically endorsed the concept of an automated mid-deck locker payload which allowed him to initiate hundreds of micro-gravity experiments in a mid-deck locker with a single command. The second flight was STS-43 in July of 1991. Even though ITA was flying its experiments without the SSDA, ITA could earn no revenue because there was no agreement which would allow ITA to sell space on its flights and no policy to allow commercial use of the mid-deck.

By the third quarter of 1991, two and one half years of meetings and negotiations had resulted in ITA being down to its last reserves. John Cassanto didn't fade away but redoubled his efforts. In large part because of the support of the Chairman and others, in 1991, NASA finally agreed to fly the MDA hardware under an innovative type of barter agreement. In exchange for half of the payload capacity to be utilized by NASA and CCDS's for microgravity researchers, ITA could market the other half to commercial customers on a pay-to-fly basis. The program was known as the Commercial MDA ITA Experiments ("CMIX").

ITA developed a business plan for a five (5) flight research and demonstration CMIX program which concentrated on the first phase of two biomedical research programs for:

- Urokinase Breast Cancer; and
- Microencapsulation of Drugs (in cooperation with the Institute for Research, Houston, Texas)

A description of the CMIX barter arrangement and the results that have been achieved are attached as Appendix 2.

Four CMIX missions were flown between 1992 and 1995 and one remains to be flown in November of this year. As a result of those missions, ITA developed a significant users base which includes domestic and international drug companies, research institutions, universities, cancer clinics, biotechnology companies and other companies undertaking proprietary microgravity research. This user base grows with each mission. Unfortunately, a substantial portion of the commercial and science data were lost on the CMIX-1 and CMIX-3 missions due to a combination of NASA hardware failures, in-flight crew errors and equipment malfunctions. Consequently, ITA requested that NASA refly those missions under the CMIX agreement--treatment which is not uncommon for experimental users of the Shuttle. NASA balked at the idea of reflights because of a provision in the agreement that specifically disavowed reflight guarantees but agreed informally, after numerous meetings, to provide additional flights to complete the commercial research that had been initiated.

However, when pressed on formalizing the agreement on the additional flights the NASA bureaucracy became evasive. In frustration, ITA sought the bipartisan support of this Committee and the NASA Administrator. Mr. Golden heartily endorsed the CMIX agreements and the additional flights. But when ITA was contacted by NASA, the additional flights were not to be provided pursuant to an extended CMIX agreement but under a new scenario with additional strings attached. After further consultation between the Chairman and the Administrator, it was confirmed that NASA was "committed to five additional flights under the same conditions as the existing flight program [CMIX]."

Although the CMIX barter agreement has worked well for ITA and its customers, including NASA, NASA has recently proposed yet another type of agreement which it calls a

"Product Development Agreement" to complete the biomedical research and honor the customer commitments made by ITA pursuant to the CMIX Agreement. ITA is working conscientiously with Code X officials to hammer out terms of the new agreement, although it is unclear whether such an agreement can be reached and whether NASA's internal clearing process can be completed in time to meet ITA's deadline of December 15, 1995; a deadline which has to be met to honor commitments to both investors and customers.

II. LESSONS

Given the twelve plus years of experience of ITA, what has been learned from the experience? We believe the lessons can be summarized as follows:

1. Infrastructure Products can be Developed Cheaper and Faster by the Private Sector - ITA's experience with the ITA Standardized Equipment Module ("ISEM") and the Material Dispersion Apparatus ("MDA") demonstrates that commercial entrepreneurs can develop market driven products faster and cheaper than similar type products can be developed through the normal NASA procurement process. Unfortunately, cheaper, faster, better and already developed doesn't necessarily translate into sales. We are aware of two examples we would like to recount.

ITA recently discovered that NASA is developing and ITA believes may already have fabricated a device which will replicate the functions and performance of the MDA. The device is known as DCAM (Dialysis Crystallization Apparatus for Microgravity). ITA has been crystallizing proteins in its MDA on Shuttle flights using dialysis techniques (one of five protein crystallization techniques available on MDA) since 1991. ITA does not know what the cost of the new NASA equipment is but we believe it to be more expensive than the MDA and know that the cost is unnecessary.

Wyle Laboratories developed its Universal Small Experiment Container ("USEC") in ten months at a cost of about $550,000. Wylie estimates that it would take three to five years and $4-6 million to make the same development conventionally. In spite of the availability of the ECLIPSE-Hab rack or a modified rack, it appears to Wyle that NASA is preparing to develop and manufacture a similar containment device. Wyle's role in that project has not yet been determined. Wyle has not been succesful in getting NASA's attention as a vendor for providers of this technology. (See the letter from Wyle's Manager of Space Engineering attached as Appendix 3 See also athe letter from Weaver Aerospace attached as Appendix 4 as further similar information.)

2. Policy to Support Commercial Space and Utilize Commercial Products and Services needs to be Strengthened - There is an inherent conflict in NASA, natural because of their procurement driven culture, between developing hardware internally or through contractors and utilizing off-the-shelf commercial products. There is a conflict between those who want to develop equipment tailored to the exact requirements of the science community, regardless of cost, and those that are

willing to adapt to what is available, are willing to modify the available hardware, and compromise if the trade-offs are acceptable. A policy must be clearly enunciated that NASA should first survey available commercial products and services and utilize such products and services before developing competing or similar products internally or through contractors. Commercial entrepreneurs want NASA as a client and are willing to modify their hardware to meet customer requirements. The policy should not merely be to utilize commercial products and services whenever possible but to actively seek means to leverage such products and services. This is not a new policy but is a policy that appears to be given only lip service.

3. Policy for Commercial Utilization of Shuttle and Space Station - Some of the difficulties ITA has encountered can be attributed to the lack of policy for the commercial use and pricing of the Shuttle mid-deck. This situation cannot be allowed to extend to the Space Station. Policies need to be put in place now which define how commercial enterprises such as ITA can utilize the Space Station. If ITA develops a better mousetrap, how can ITA get it to the Space Station and utilize the Station infrastructure to (1) demonstrate its hardware, (2) perform product development, and (3) sell its services to others? A certain amount of Space Station resources must be made available to commercial developers to let the market laboratory as well as the science laboratory operate in microgravity. It is not enough to state the Space Station will be available for commercial users and ignore how commercial users are to obtain such access. It is ITA's opinion that one of the best means would be to keep the barter mechanism alive. The barter transaction provides NASA and experimenters with access to equipment to which they otherwise would not have access and provides the entrepreneur with a mechanism to demonstrate equipment and hopefully build a market. Product Development Agreements alone are not sufficient. As demonstrated in the attachments to this testimony, there is support for continuing the barter arrangements. Furthermore, commercial users of Station must have access through either the CCDS' or through NASA directly. A dual path is required because neither path alone meets the requirements of all users.

4. Policies need Teeth - While strong policies are needed, the basic truth is that policies alone are worthless unless officials down the line of command are sufficiently motivated to carry them out. This is, without a doubt, the greatest weakness in the present system. No doubt the agency has been trying to implement various reforms to streamline the procurement process and can point to some success stories. But, can anyone dispute that there is something seriously wrong when industry must repeatedly seek the assistance of Congress and the intervention of the Administrator to enforce the policies that transcend administrations? ITA wants to make it clear that it is not questioning the commitment and intentions of NASA leadership. But when the agencies red and blue teams go away, often it is back to business-as-usual in the trenches.

The question is, of course, how to put teeth in any policy. We have two concrete suggestions: (a) There needs to be a troubleshooter with real power that can cut through competing interests, competing budgets and competing offices, and to whom industry can turn when things go wrong. Such a person must be someone who reports directly to the

Administrator, has real commercial experience and real dedication to reforming the system to make it work; (b) NASA personnel must be incentivized to make the commercial policies work. What you have done for U.S. commercial development should be an important and substantial part of the annual review of each and every NASA employee with real rewards for performance. Congress should explore other means of providing real incentives for NASA employees to support commercial space.

III. CONCLUSION

Entrepreneurs need access to space. They need the support of Government not only to develop products and services but support to develop and demonstrate their hardware. They don't need money, although money would be nice. What they need is access to the government infrastructure such as the Shuttle or the Space Station. They need stable and predictable policies. And they need commitment from Government to carry out those policies and a commitment that government will not compete with industry. Commercial space is not just spin-offs of technology from government programs. Commercial space is about innovative, entrepreneurial hardware, products and services. What we need as a nation, is to find a way to enable and then incentivize NASA to foster commercial space and to leverage commercial space to achieve additional fiscal and scientific benefits. NASA's charter requires NASA to seek and encourage the commercial use of space, as well as to preserve the U.S. as a leader in space science and technology. There has to be room for both. If the U.S. does not implement such a policy for commercial uses of the Space Station, the nation will be wasting a precious asset and handicapping itself in the global space market of the next century. Whatever the market may be for microgravity in the next century, the market surely will develop and we believe it will be substantial. The U.S. Government can accelerate the growth of that market and enhance the benefits for the U.S. industry and economy. ITA wants the U.S. to aggresively lead so that a fair share of the benefits of commercial microgravity are reaped by the U.S. and not just by those who would sow the fields that we, the United States, have plowed.

Appendix 1

ITA's AUTOMATED SPACE PROCESSING LABORATORY - THE MDA MINILAB - TYPICAL COMMERCIAL SPACE HARDWARE

ITA has been responsive to both the National Space Act as amended and to the various administrative policies on commercial space to encourage the private sector to invest in space activities. ITA has raised investment capital, obtained loans, and obtained grants from the Commonwealth of Pennsylvania to develop a spectrum of commercially developed space infrastructure hardware to participate in the commercial space market as a partner with NASA. An example of an ITA space processing hardware device developed solely by the private sector is our automated laboratory, the Materials Dispersion Apparatus (MDA Minilab), which has the capability to process 100 separate experiments. The device can be thought of as 100 tiny test tubes that mix sample fluids and/or solids at precisely determined time intervals.

For a typical Space Shuttle mission four of the MDA minilabs are integrated into a carrier and placed inside a thermally controlled environment in a standard Shuttle mid-deck locker. The integrated payload shown represents ITA's CMIX payload that flew on two Shuttle missions this year on STS-67 in March 1995 and on STS-69 in September 1995. This commercial payload provided some 400 data points in a single mid-deck locker. The commercial experiments consist of ITA biomedical projects such as the protein crystallization of urokinase to ultimately develop a drug to combat breast cancer metastasis; the Microencapsulation of Drugs, a drug delivery system for The Institute for Research, in Houston Texas; protein crystal growth for two pharmaceutical companies that wish to remain anonymous; various types of protein crystallization for five US and international organizations; collagen assembly for a German university; inorganic crystal growth for a US organization; seed germination for US elementary and high schools; cell growth experiments for the Consortium for Materials Development in Space at the University of Alabama in Huntsville; and many others.

NASA has flight hardware that can perform this same function but the government hardware is costly and does not have the multiple science discipline capability provided by the commercial hardware. It would take at least three NASA hardware devices to perform this same mission using three separate mid-deck lockers. The cost to develop the hardware (existing hardware and programs) and to support the mission would be at least a factor of 10 to 20 more than to use commercially available multi-technology multi-user hardware such as the MDA minilab.

A new generation MDA automated laboratory with more capability is being developed with private sector resources to fly in 1996. It will have the capability to obtain up to 1000 data points in a single Shuttle mid-deck locker with TV recording capability of selected experiments. ITA expects to fly this hardware on both the Shuttle and the Space Station as a commercial user.

Appendix 2

CMIX BARTER AGREEMENT DESCRIPTION AND RESULTS

ITA is presently the only company in the United States to hold this unique type of Commercial Shuttle flight agreement (through the Consortium for Materials Development in Space at the University of Alabama in Huntsville, one of NASA's Centers for the Commercial Development of Space) which provides a very strong incentive for the private sector to invest in space activities. Although the agreement took three years to consummate with NASA, it is innovative and provides advantages both to ITA, NASA, and the nation. The barter agreement can be the model for other hardware developers and for the international Space Station, which would save NASA the time and money to develop space processing hardware through its normal procurement procedures. It has been conservatively estimated that commercially developed private sector space hardware can be developed at one tenth to one twentieth the cost of government developed space hardware. In fact, there are several commercial space hardware carriers and space processing devices that outperform and cost less that comparable government developed hardware. This information can be made available to interested parties.

The Barter agreement that ITA presently has is a "value exchange" whereby ITA allows the NASA CCDS community to utilize one half of its private sector developed generic space processing hardware (the MDA Minilab) in exchange for allowing ITA to fly on the Shuttle. The remaining half of the MDA Minilab hardware is revised for ITA to either perform its own microgravity research, or to enter into joint business ventures or to sell the capacity to users. All of the products and technology developed from the space flight experiments remain the property of the experimenters and ITA. It is true commercial space where profit dollars are being generated. In fact, it is the only true commercial space operation presently flying on the Shuttle. It is a model worth emulating for other hardware providers and for use on the international Space Station. The present agreement is called CMIX which stands for Commercial MDA ITA eXperiments.

At the present time after four flight (two of those flights were only partially successful due to NASA hardware malfunctions, one ITA hardware malfunction and the an on-orbit operation errors); However, in general the program has been a great success. ITA has four major thrusts:

- Biomedical Experiments The major ITA biomedical research project involves a program to grow protein crystals of the enzyme urokinase. Urokinase is always present when the spread of cancer occurs, particularly breast, colon and other forms. The structure of urokinase is unknown. ITA has formed a consortium of cancer institutes, research institutes, private sector companies and universities to attack this problem. The company is trying to grow a large enough urokinase protein crystal using the microgravity environment of space so that the structure can be determined through x-ray diffraction analysis. The key players are set up to then design a pilot drug and conduct clinical trials. The end product would be a drug to combat cancer metastasis. This is a long term project which may take up to 10 years to get to the end product of a drug on the market, but we must start. The CMIX barter agreement with NASA is that start.

  The microencapsulation of drugs is another project that is being conducted with the Institute for Research in Houston, Texas that utilizes ITA's commercial hardware and access to space to continue research. Ultimately, this will manifest itself into a drug delivery system for cancer therapy.

  Several drug companies are flying using the CMIX flight agreement and the ITA space processing hardware to attempt to grow protein crystals, again to ultimately develop new drugs. These companies prefer to remain anonymous. Other US concerns are performing

research in the area of inorganic crystals and proprietary microgravity research. ITA has interfaced with some 15 US companies, research organizations and universities. Some of these organizations are involved in joint ventures and some of these organizations are "pay to fly" customers.

- International Users: ITA has several international marketing agreements and paying customers who perform research using ITA's automated laboratories and fly on ITA's CMIX flights. For the first time in a long time, funds are flowing across the Atlantic and Pacific Oceans in the right direction to the U.S. In addition, ITA has Canadian researchers who in addition to being paying customers are also involved in ITA's commercial biomedical research and perform analysis and tasks needed to keep the research on track and on schedule. In fact, U.S. users are now employing protein crystal growth techniques developed by Dr. Sygusch of the University of Montreal, Canada which he pioneered using the ITA commercial space processing hardware. This technique is being shared with U.S. investigators. Our European users are also going to fly on the international Space Station, and the research they perform is a precursor to station operations. We have a fair honest agreement which allows both companies and both the U.S. and Europe to benefit from commercial collaboration.

- Education Program: ITA established as a part of the CMIX barter program to donate a portion of each CMIX payload to "hands on" student space experiments. ITA donated the employee time and the hardware to work with students to conduct meaningful experiments. It is a most rewarding program that continues to pay dividends for both ITA, NASA, and the nation. This program is funded solely by ITA, and is our way of giving back something to the system. At the present time ITA has sponsored 12 schools in seven states and have involved some 400 students and 20 teachers. Probably the most rewarding feedback we have obtained is that some of the students have actually changed their curriculum from business to science and engineering as a direct result of the Shuttle experiment that they worked on. ITA has made a commitment to fly student experiments as long as the company flies experiments in space.

To summarize, the CMIX program which is based on the barter agreement works. It works from a business point of view. It works from NASA's point of view because the agency didn't have to fund the development of generic space processing hardware for the CCDS community or for NASA. It is a win-win for all. We believe that this type of agreement should be used as a model for commercial users on Space Station with a direct agreement with NASA or through a CCDS.

CMIX FOLLOW-ON PROGRAM FOR SPACE STATION

ITA's vision for Space Station is to provide more capability in the same volume (essentially a mid-deck locker) so that more experiments can be conducted thereby lowering the cost of doing commercial microgravity research, and in addition providing an enhanced probability of success. Figure 2 presents an overview of ITA vision for space station. As stated previously, the present hardware flying as the CMIX payload on the Space Shuttle has the capability for 400 samples or separate experiments in a single mid-deck locker. We have developed new hardware with private sector funds that has significantly larger volumes of fluids and samples. This hardware is called the Liquids Mixing Apparatus (LMA) and also currently flying on the Shuttle. The next generation MDA Minilab when housed in a middeck locker will have the capability to obtain some 1000 independent data points or experiments at the press of a button. This hardware will also have optical capability and be able to record TV images of the fluids mixing or crystals growing. The upgraded hardware is called the Double MDA with optics or DMDA-O.

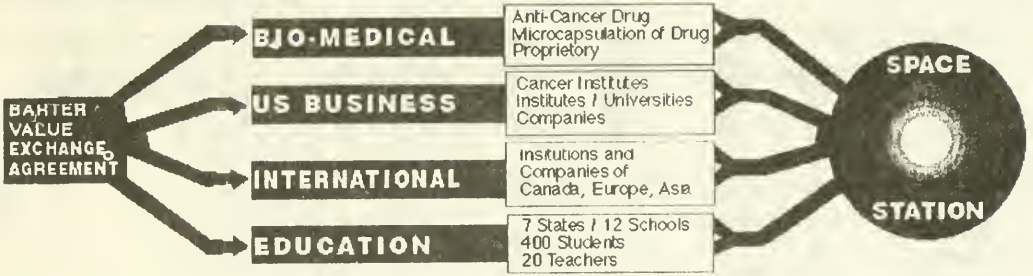
Our concept is to have a Biotechnology Processing Facility (BPF) which is essentially a commercial rack. This commercial rack would have the capability to have three mid-deck locker configurations of DMDA-O automated laboratories at three different temperatures for the different

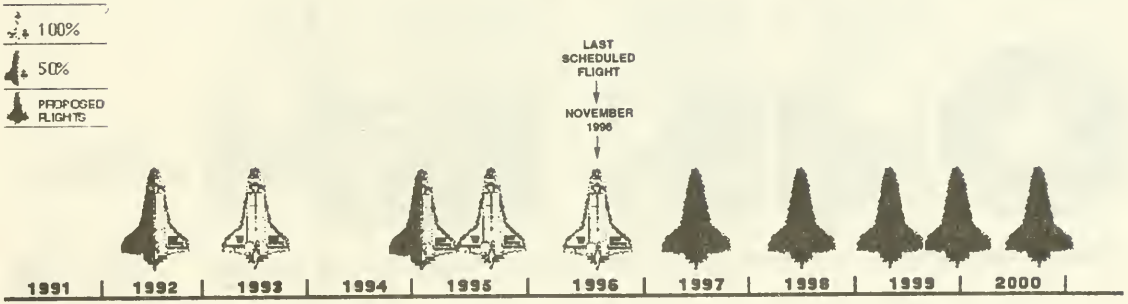
types of experiments to be conducted, e.g., protein crystal growth, membrane casting, zeolite crystal growth, cell biology, collagen formation, seed germination, etc.. In addition, the Commercial BPF rack would also have an Electrophoresis space processing device constructed by the Center for Cell Research at Penn State University to separate commercial products. There would be a hardware device for the microencapsulation of drugs, and finally some type of cell culture or space biology hardware to continue that type of commercial research. Our vision is to have the BPF a "one stop" shopping biotechnology rack where commercial users can lease time on the various space processing hardware devices that satisfy their commercial research requirements. It would be a "pay to use" facility available to all users of the space station. In addition, a percent would be reserved for the continued ITA biomedical research and for our student space outreach experiment program.

However, for our vision and our concept to work, the nation needs a good coherent policy for commercial users to use the international space station. The policy must allow US commercial users to have access to the station to conduct their own commercial research independent of NASA, to have joint ventures with other commercial entities, and to make a profit. ***It is obvious that the CMIX type barter agreement that is currently being used to fly ITA commercial payloads on the Shuttle could be used as a model for Space Station.*** In addition, an alternate approach would be to use the NASA CCDS mechanism to fly commercial payloads. The U.S. private sector, however, must be given the choice. The penalty for not allowing U.S. firms to fly on the space station to perform commercial research is that this nation will not be competitive in the global market in the next century. We will forfeit that market to the international community (Europe, Japan, Canada, and Russia) that is also flying on Space Station. Our international partners are aware of the products and technology that will come from microgravity research. We must insist that NASA pay more attention to commercial space activities and they must create an environment for U.S. private sector investment in space as the National Space Act mandates.

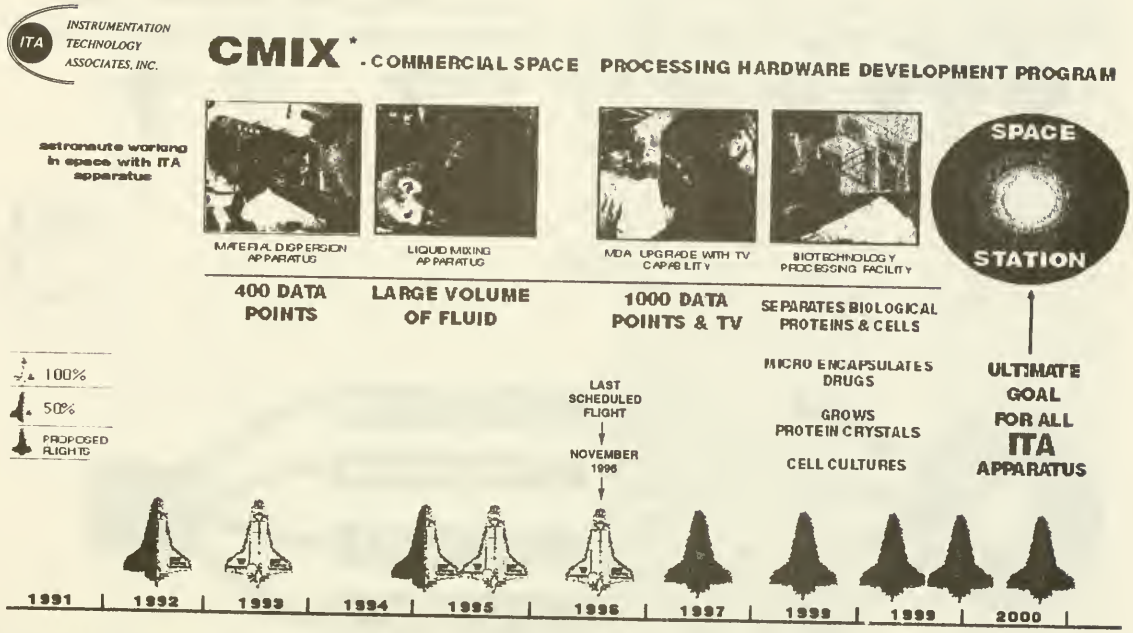
INSTRUMENTATION TECHNOLOGY ASSOCIATES, INC.

CMIX* - OVERVIEW OF COMMERCIAL EXPERIMENTS


BARTER / VALUE EXCHANGE AGREEMENT
BIO-MEDICAL
US BUSINESS
INTERNATIONAL
EDUCATION
Anti-Cancer Drug Microcapsulation of Drug Proprietory
Cancer Institutes Institutes / Universities Companies
Institutions and Companies of Canada, Europe, Asia
7 States / 12 Schools 400 Students 20 Teachers
SPACE STATION



* CMIX - Commercial MDA ITA eXperiments



* CMIX - Commercial MDA ITA eXperiments

wyle laboratories

November 1, 1995

Instrumentation Technology Associates, Inc.
35 East Uwchlan Avenue, Suite 300
Exton, Pennsylvania 19341

Attention: Mr. John M. Cassanto, President

Reference: ITA Memorandum No. 95-138

Subject: Barter Arrangement with NASA to Promote Commercial Space Activities for Shuttle Flights and for Space Station

Dear John:

My position on bartering the use of hardware systems with NASA is exactly the same as yours. While space activities represent a very small part of Wyle Laboratories' work, it is an aspect of the American scientific and technical fabric that Wyle has supported since the company's beginning in 1949. In fact, Wyle has been squarely in the middle of every major space and defense program that has come along. Since 1984, Wyle has been involved in meaningful Space Station research. In 1988, it was apparent that the Space Station work would be the domain of only gigantic aerospace companies and the little companies would have to find something else to do.

Wyle's niche in the space market was payloads, and we were encouraged by NASA to find a payload-related technology that we could pioneer and bring to the marketplace. It was to be an item of space hardware infrastructure that Wyle could develop with its own money and that NASA would not have to design and develop. It was to be leased to a customer or to NASA for a customer. We developed an amazingly versatile payload containment system that enabled a scientist to fly crude hardware at a fraction of the cost and schedule required to produce sophisticated hardware. It is called the Universal Small Experiment Container (USEC). Wyle demonstrated the value of USEC for housing a very complex furnace system for processing metal alloys in space. USEC flew an amazing three Space Shuttle missions in 18 months. The furnace system was developed from start to finish in 10 months as compared to a typical time of 5 to 10 years and at a cost of about 1/20 typical cost. The success of the USEC technology is an undeniable fact. USEC's can be produced in a variety of sizes and shapes to accommodate any imaginable payload or experiment. USEC is one "wheel" that NASA does not need to reinvent. We have not been successful at getting NASA's attention as a vendor or provider of this simplifying technology. NASA prefers to develop its own versions of USEC.

Sincerely,

WYLE LABORATORIES

Ronald E. Giuntini

Dr. Ronald E. Giuntini, P.E., CR.E., C.P.L.
Manager, Space Engineering

Wyle Laboratories, Inc. 7800 Highway 20 West P.O Box 077777 Huntsville, AL 35807-7777 Tel: (205) 837-4411

FLIGHT-PROVEN PAYLOAD CONTAINMENT SYSTEM

AVAILABLE FOR LEASE

USEC

UNIVERSAL SMALL EXPERIMENT CONTAINER

USEC a tailored system

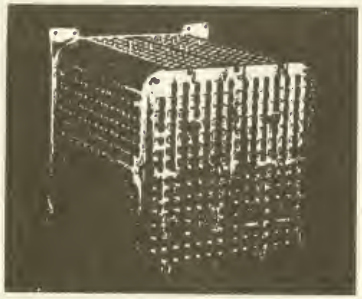
Simplicity is the essence of the Universal Small Experiment Container (USEC), yet USEC is more than a simple box—it is a payload containment system with embedded intelligence. USEC can be customized to suit your individual needs and can be fabricated in various sizes. Developmental transformations include adding pressure and vacuum vessel capabilities, lightening pockets for weight reduction, external mounting fixtures, resource adapters, and internal mounting hardware.

Flight-proven

USEC is the flight-proven containment system for a complex furnace that flew aboard SPACEHAB-01 on STS-57 in July of 1993, on STS-60 in February 1994, and will fly again on STS-63 in February 1995.

USEC safety

USEC delivers a new level of safety with its unique pressure vessel design, enabling the experimenter to reduce the impact of complex and costly manned spaceflight safety requirements that dictate three levels of containment for any potentially hazardous/toxic materials and processes within the experiment. With USEC, the experimenter can quickly respond to flight opportunities on all manned space carriers with a minimum investment.



The Wyle solution

Many great ideas fade if they never get off the ground. Wyle Laboratories' USEC offers a convenient alternative to the time-consuming and expensive payload development activities required for most space experiments.

USEC is compatible with the Space Shuttle Middeck, Spacelab, and SPACEHAB. The system allows researchers to perform experiments more efficiently while adhering to strict NASA requirements for the safe processing of potentially hazardous materials.

Middeck

Spacelab

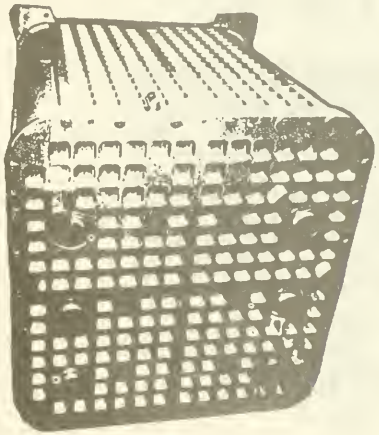
Spacehab

For further lease arrangements or information, contact:

- Dr. Ronald B. Giuntini
  Space Engineering
  Wyle Laboratories
  (205) 837-4411, ext. 383
  FAX: (205) 830-2689

USEC™ MODEL II....
THE SUPER PAYLOAD CONTAINMENT SYSTEM

The Model II is a super container because of its new design features that meet the unique safety requirements of NASA Lewis Research Center in Cleveland, Ohio. The first Model II is being developed to house a sophisticated optical payload (Physics of Hard Sphere Experiment or PHaSE) which contains some highly hazardous materials and is to be located in the Space Station EXPRESS rack in the Spacelab module of the STS-87.



PHaSE is a NASA-LeRC FAST-TRACK payload which means that from concept to flight will be about one-half the time of a payload that is not on the FAST-TRACK. USEC Model II is an item of enabling hardware infrastructure that helps reduce the development time and cost. That's the reason its there.

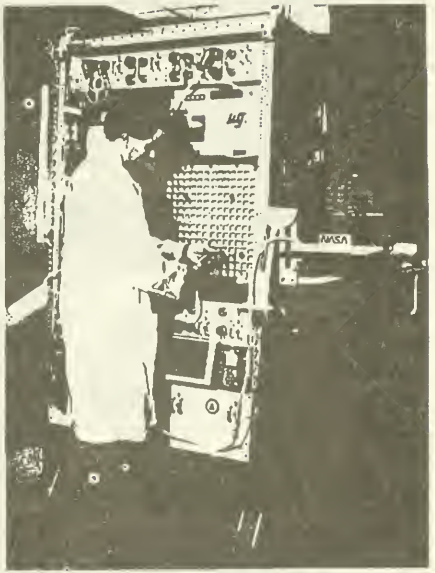
SPACE STATION EXPRESS RACK

PHaSE will fly in the EXPRESS rack on STS-87. EXPRESS will be making precursor missions in Spacelab prior to going to the Space Station. STS-87 will be the initial Space Shuttle mission for the EXPRESS and the USEC™ Model II will be aboard.

For additional information on USEC™, contact:

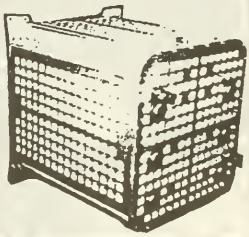
Dr. Ronald E. Giuntini, P.E.
Phone: (205) 837-4411, ext. 383
FAX: (205) 837-5216

WYLE LABORATORIES
P.O. Box 077777
Huntsville, Alabama 35807-7777



wyle laboratories
SPACE ENGINEERING

YOUR GREAT IDEAS WILL FLY WITH US TO THE SPACE STATION



Many great ideas never get off the ground. That's why Wyle Laboratories developed USEC™ - the Universal Small Experiment Container. The flexible USEC concept offers a quick, economical alternative to the traditional payload development and integration process.

USEC™ containers are compatible with the Space Shuttle middeck, Spacelab, SPACEHAB, and Space Station. The USEC approach lets researchers concentrate on their experiments instead of the packaging. They can rest assured their payload will meet strict NASA requirements for the safe processing of potentially hazardous materials. USEC™ enables the experiment designer to transfer much of the design burden from the experiment to the USEC™ Containment System. NASA's Space Station EXPRESS rack is designed to accommodate small payloads at the Space Station. These "sub-rack" payloads are those flown in the Orbiter middeck, Spacelab, and SPACEHAB as well as new Space Station payloads. Missions are underway now to fly the EXPRESS rack in Spacelab as a precursor to the Space Station. USEC™ will be there carrying the NASA Lewis Research Center's PHaSE payload in the first EXPRESS flight on STS-87. Book your EXPRESS flight now in USEC™.

The versatile USEC™ system can open the door to space for many different industrial products and processes. Don't be constrained by conventional thinking! Let your great ideas fly with Wyle's USEC™ Payload Containment System.

Call Dr. Ronald Giuntini, P.E.
(205) 837-4411, ext. 383
or FAX (205) 837-5216

wyle

QUICK IS BEAUTIFUL

THE FASTER, BETTER, CHEAPER AND SMARTER APPROACH TO SPACE WITH USEC™ TECHNOLOGY

USEC-1	USEC-3	USEC-5	USEC-7	USEC-X™
BASELINE USEC (REFERENCE)	1/2 [BASELINE HEIGHT]	1.5 [BASELINE HEIGHT]	[BASELINE DEPTH] +6"	RACK MOUNT

SIZES AND SHAPE VARIATIONS (EXAMPLES)

Wyle's payload enabling technology (referred to as USEC™ Technology) denotes features and attributes designed, built, and tested into a family of payload containment systems referred to as Universal Small Experiment Container (USEC). With USEC™ Technology, much of the experiment apparatus development time and cost can be eliminated and a large portion of that burden can be transferred to the payload containment system.

Wyle Laboratories engineered, designed, developed, manufactured, integrated, and, of course, documented the payload known as the ECLIPSE-HAB. Wyle did all of this pretty much from scratch for $550,000 and did it in 10 months. By striking contrast, this was about 1/15 as costly and about 10 times faster than the "business-as-usual" development paradigm that is employed for the typical payload that flies in the manned space environment aboard the STS orbiter. This is not s trival accomplishment. In fact, it has never been done before nor since.

ECLIPSE-HAB could not have been possible had it not been for USEC™. Plain and simple—a complex payload with hazardous materials, high temperatures, etc. must have three levels of containment (3 inhibits). To develop ECLIPSE-HAB without the USEC™ and build in the three levels of containment would require that it be several times larger in volume and several hundred pounds heavier. It would take 10 times as long and cost 15 times more to develop. Also, it would be too big to fly in the SPACEHAB module.

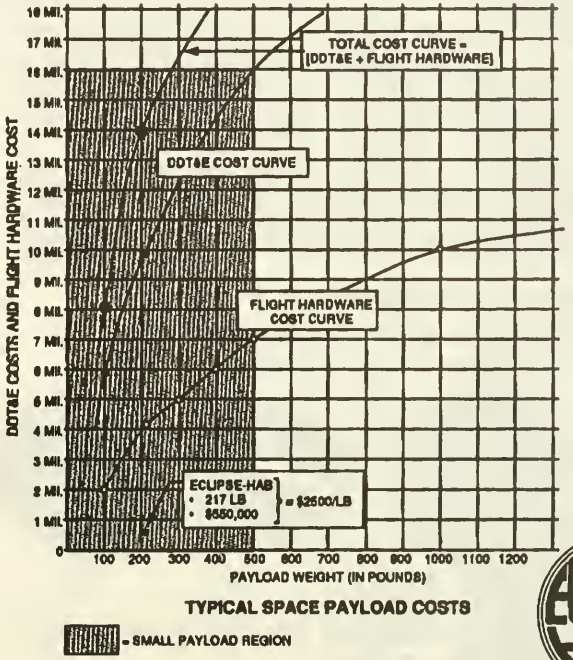
USEC payload containment systems are developed with embedded intelligence. We refer to these designed-in features as intelligence because we anticipated the designer's and safety engineer's problems and incorporated enabling technology in the containment systems to short-circuit and eliminate these problems altogether. Several engineering transformations are required to transform a simple box into an intelligent payload containment system. For additional information contact:

Dr. Ronald E. Giuntini, P.E.
P.O. Box 077777, Huntsville, Alabama 35807-7777
Phone (205) 837-4411, ext. 383 FAX (205) 830-2689

wyle laboratories
SPACE ENGINEERING

FASTER, BETTER, CHEAPER AND SMARTER APPROACH TO SPACE

FASTER, BETTER, CHEAPER.... IS SMARTER



The total cost for a typical payload is the sum of the DDT&E cost and the flight hardware cost. Based on this, ECLiPSE-HAB's cost if developed by typical contractor would run around $14 million. Instead, Wyle developed ECLiPSE-HAB for about $550K (approximately 1/25 typical or business-as-usual cost).

Also, the development time was dramatically shortened...only 10 months as compared to the typical or business-as-usual payload development time of 6 or more years (about 1/7 of typical development time).

Contact: Dr. Ronald E. Giuntini, P.E.
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Wyle Engineering Division

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wyle laboratories
SPACE ENGINEERING

WEAVER
AEROSPACE

6 March 1995

Instrumentation Technology Associates, Inc.
35 East Uwchlan Avenue, Suite 300
Exton, Pennsylvania 19341

Attention: Mr. John M. Cassanto, President

Reference: ITA Memorandum No. 95-138

Subject: Barter Arrangement with NASA to Promote Commercial Space Activities aboard Space Station and/or the Space Shuttle.

Dear John:

I strongly agree with your efforts to promote the establishment of barter agreements with NASA, whereby those of us with commercial space services of value to NASA can exchange these services in return for space flight time. As long as the only access to the station is via the space shuttle, the station will remain unaffordable for most commercial enterprises. The barter concept is an effective and immediately available alternative.

Of even more fundamental importance for a sustained manned presence in space, as we move into the Space Station era, is privatizing portions of on-orbit operations. We must begin moving from a government-operated manned space flight capability, wholly dependent upon tax revenue, to a privately-owned and commercially viable manned space flight industry that generates tax revenue.

As you know, Weaver Aerospace is now its 17th year of operation in the commercial space industry. Our primary line of business is the development of Extravehicular Activity (EVA) solutions for manned operations in space. Our personnel have worked directly on all US manned space programs since Gemini, both for NASA and for industry. We contributed extensively to the development of the Hubble Telescope EVA maintenance concept and to the EVA assembly and servicing techniques for the space station. We operate several jet research aircraft providing commercial access to zero-g, lunar-g, and Mars-g environments. We utilize the McDonnell Douglas Underwater Test. Facility in Huntington Beach, CA, for underwater EVA tests, using our own test conductors and EVA-trained crewmembers.

Weaver Aerospace Company
P.O. Box 588, Aptos, California U.S.A. 95001-0588 TEL. (408) 688-8661 FAX: (408) 688-7936

CASSANTO p2

Since 1992 Weaver Aerospace has been attempting, thus far unsuccessfully, to sell parabolic research flight services to NASA. Based on the intent of HR2403 (privatizing parabolic microgravity and sounding rocket research) this market may now be mandated to the private sector. If this happens, it is our professional opinion that the market will be best served by separate procurements for astronaut training, and for research and development flights. Weaver Aerospace will bid on the research and development procurement.

Looking ahead to the space station era, EVA will be required to maintain and upgrade the station itself, and to support assembly and servicing of both attached and free-flying payloads. These tasks will often be complex, and will be best accomplished by a highly proficient EVA crew whose full-time job is to conceptualize, develop, verify, and then actually perform these operations. Manned spaceflight is now maturing to the point that commercial astronauts are a better solution for these applications than the long-duration science astronauts who will form the basic space station crew.

A primary corporate Weaver Aerospace business objective is to provide such specialized EVA services for commercial customers in earth orbit beginning early in the space station operational era. This service has the basic pre-requisite characteristics for a win-win barter arrangement with NASA, in which we would perform complex station-related EVA assembly, maintenance, and servicing activities, in return for flights to and from the station and for some additional on-orbit time which could then be sold to our commercial customers, or to NASA for selected complex non-station EVA tasks.

John, I applaud your tireless support of the commercial space industry, and I hope that these thoughts are of use to you.

Sincerely,

Lee Weaver

Lee Weaver
President

LW:slc

The CHAIRMAN. Very good. Thank you very much.
Mr. Rossi.

STATEMENT OF MR. DAVID ROSSI, SENIOR VICE PRESIDENT FOR BUSINESS DEVELOPMENT, SPACEHAB, INC., ARLINGTON, VA

Mr. ROSSI. Thank you, Mr. Chairman, members of the committee, for the opportunity for Spacehab to appear before you today.

I have submitted a written copy of my testimony for the record but I will summarize for you now.

The CHAIRMAN. Without objection, the entire statement will be included in the record.

Mr. ROSSI. I would like to raise an issue which may be slowing progress in achieving commercialization goals. Specifically, the imbalance between commercialization initiatives and NASA procurement practices. We're certainly not here today to complain or to say that one approach is better or worse. I think Ms. Lee had it exactly right. They're just different and we need to merge them to achieve our goals.

To attract investment capital for any project industry must demonstrate that a significant return, usually 20 percent to 50 percent compounded annually, is available to the investor. For comparison, an investor who placed his funds in a large equity mutual fund in January already has achieved a 40 percent return this year. This 40 percent return had been obtained with relatively moderate risk, certainly not the high level of risk associated with space activities.

Looking back over a five year period investors have received average annual rates of return for moderate risk investments equal to 17 percent. After industry raises capital and develops a commercial space product that is offered to NASA current NASA procurement practices require that evaluators of the proposal focus on the costs incurred by the contractor instead of the value received by NASA. This cost versus value approach has four consequences.

First, the amount of profit that can be received by investors is limited. Second, the cost basis of the asset used to provide the service is amortized by the government, as if the government owned the asset. Third, industry's use of commercial practices and the savings they create are not considered in the price evaluation. Therefore, private industry is discouraged from providing commercial space products and services.

Of course, as the predominant or sole buyer of commercial space products and services today, NASA must ensure that it is paying a fair and reasonable price. However, there are no legal barriers that prevent the government from considering the value of the service or product instead of its cost when evaluating the price.

If two or more competitors can respond to an RFP NASA can be assured that the price to be paid is fair and reasonable, regardless of the cost that industry will incur and the profit that may be achieved. If only one competitor responds to an RFP or if NASA receives an unsolicited proposal that has merit there are four ways to determine if the price offered is fair and reasonable.

First, NASA can determine if the service or product is being procured by non-government sources. Second, if it is not being purchased on a commercial basis NASA can determine if other govern-

ment organizations are buyers. Third, if there are no commercial or other government buyers NASA can determine if similar services or products previously have been purchased by NASA itself. Finally, if none of these first three conditions can be met NASA can conduct an independent should cost price analysis using NASA's own internal cost and pricing models and outside consultants.

I'd like to create a hypothetical example to illustrate this issue. Using commercial practices, industry may be able to develop a component of the space station that is desired by NASA for $100 million. NASA, using its own analysis, may anticipate that $500 million may be required if standard government contracting practices were used. Industry could offer to sell this component to NASA for $150 million, thereby saving NASA $350 million while earning a $50 million profit—a good deal for both parties.

However, current procurement practices would require that NASA pay no more than $118 million for this component. That is industry's cost of $100 million plus the government cost of money, currently about six percent, plus a fee which can be up to 12 percent but is usually a lot less.

Let me move from a hypothetical to a real example. The Spacehab program required an investment of approximately $250 million to develop two flight modules and to provide integration services for four missions. Spacehab raised over $100 million in private funds to develop and produce and operate the modules. NASA subsequently enters into a $184 million fixed price contract with Spacehab to lease the assets for four missions. A NASA funded study conducted by Price Waterhouse using NASA's own cost models concluded that NASA would have incurred a $1.2 billion expense to provide an equivalent capability using standard practices. Spacehab modules have flown successfully on each of their three missions to date. NASA recently entered into another $54 million fixed price lease contract with Spacehab to provide logistics support to MIR. Although both contracts are fixed price, Spacehab's prices are still evaluated on the cost to provide these services, not on the value offered.

In conclusion, I believe commercialization can be promoted by focusing on the potential for investors to earn returns commensurate with the risks of the space industry. Ensuring that NASA is paying a fair price for commercially offered products and services can be determined through competition or by comparison with prices paid by other non-NASA users. If NASA becomes the predominant or sole user of a commercial service offered by a single provider an independent should cost analysis could be conducted contrasting the price to be paid to the cost of providing the desired services using standard practices, thereby promoting commercialization and achieving substantial savings when procuring space hardware and services.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Rossi follows:]

SPACEHAB®
DEVELOPERS OF SPACE HABITAT MODULES

CORPORATE OFFICE
Suite 150
1 Jefferson
Arlington, VA 2220
Phone (703) 414-8
Fax (703) 414-81

Written Statement of

David A. Rossi
Senior Vice President for Business Development
SPACEHAB, Inc.

on

Value Versus Cost Pricing

at the hearing on
NASA Purchasing in the Earth-Space Economy

before the
U.S. House of Representatives
Committee on Science

8 November 1995

Mr. Chairman and Members of the Committee:

Thank you for the opportunity for SPACEHAB, Inc. to testify today before the Committee on *Value Versus Cost Pricing* at your hearing on NASA Purchasing in the Earth-Space Economy.

Great interest has been expressed in expanding private industry's participation in space activities through commercialization and privatization initiatives. Industry already has offerred in the past, and is prepared to offer in the future, commercial space products and services to NASA and other government organizations. Substantial cost savings and enhanced services have been achieved when the government procured services developed using commercial practices.

However, there are several significant issues that have made it difficult to achieve the level of commercial participation in space activities that had been anticipated a decade ago. Some of these issues are well known and have been discussed extensively, such as the difficulty of making private investments when government contracts can be terminated for convenience or for lack of appropriations, or the long tradition of government ownership and operation of space assets, or the practices of the government monopsony for space products and services.

Today, I will discuss another issue that has not received as much attention: the conflict between commercialization goals and the implementation of procurement practices.

Commensurate Returns

To develop a commercial space product or service, industry must invest private capital.

To attract this investment capital, industry must demonstrate that a return commensurate with the risk, usually 20% to 50% compounded annually, is available to the investor by selling the product or service to NASA and others. For comparison, an investor who placed his or her funds in a large general equity mutual fund in January already has achieved a 40% return so far this year.

This return has been obtained with relatively moderate risk -- certainly not the level of risk associated with space activities. Over longer periods, mutual fund investors have received compounded annual rates of return for general equity funds equal to 17% for the past five years. The most conservative investment available, U.S. Government Treasury Bonds, currently pay approximately 6% with no risk of principal loss. Investors in space activities are justified in seeking returns that are commensurate with the unique and high risks of space endeavors and government contracting.

Price Evaluation

A company engaged in the commercial space industry, like a company engaged in any other industry, attempts to anticipate customer requirements and to develop a product or service to satisfy these requirements. Meeting these requirements usually means expending investment funds prior to a contract commitment from NASA. The new product or service is then offered under existing Federal Acquisition Regulations (FAR). However, when evaluating the price of commercial proposals, submitted either in response to a NASA request for proposals (RFP) or as an unsolicited proposal, current NASA procurement practices require that evaluators focus on the ***cost*** to the contractor instead of the ***value*** to NASA of the proposal.

This cost versus value approach has four consequences.

1. The amount of profit that can be received by investors in a commercial space project is limited to the government cost of money plus a negotiated fee. However, this level of profit is not commensurate with the unique risks associated with commercial space activities or with other moderate risk investment alternatives.

2. If the contractor is offering a service, the cost basis of the asset used to provide the service is "amortized" by the government such that future lease prices must be reduced over time as the government uses more of the service. This practice requires that the lease fee eventually be reduced to zero after the full amortization period, regardless of the asset's remaining economic value to NASA and others.

3. The "savings" realized by the government that are created by industry's use of commercial practices are not considered in the price evaluation.

4. Therefore, private industry is discouraged from providing commercial space products and services.

The reason usually provided for evaluating cost, instead of value, is that the government must be certain it is receiving the lowest possible price because the government usually is the predominant or sole user of the commercial space service or product.

Legal Barriers

There are no legal barriers that prevent the government from evaluating the value of a service or product instead of its cost.

If NASA determines that it has a requirement for a certain capability, an RFP to satisfy that requirement can be released. If two or more competitors can respond to the RFP, NASA can be assured that the price to be paid is fair and reasonable, regardless of the cost that industry will incur for providing the service or product and the profit that may be achieved.

If only one competitor responds, or if NASA receives an unsolicited proposal that has merit, there are four ways to determine if the price offered is fair and reasonable.

1. NASA can determine if the service or product is being or recently has been procured by non-government sources.

2. If the service or product is unique and therefore not being purchased on a commercial basis, NASA can determine if other government organizations are buyers.

3. If there are no commercial or other government buyers, NASA can determine if similar services or products have been, or are being procured by NASA to compare prices.

4. If none of the first three conditions can be met, NASA can conduct an independent price analysis using internal NASA cost and pricing models and outside consultants.

Hypothetical Example

Industry may be interested in providing a new component of the International Space Station (ISS) on a commercial basis.

However, industry cannot attract investment capital to develop such a component without either a firm lease or purchase commitment in advance from NASA ***or*** the freedom to set a price that is based on value rather than cost. With value pricing, industry does not require purchase commitments or guarantees.

Using commercial practices, industry may be able to develop and build a component of the ISS desired by NASA for $100 million. NASA's own cost analysis may indicate that $500 million would be required to develop an equivalent capability using standard government practices. Although industry could offer to sell the component to NASA for $150 million, thereby saving NASA $350 million, current interpretations of procurement practices would require that NASA pay no more than $118 million -- that is: industry's cost ($100 million), plus the government cost of money (currently 6%), plus a fee (up to 12% but usually less). Using this approach (paying cost plus a fee), an investor will not receive a return commensurate with the risk.

If the contractor offers to lease the capability to NASA rather than to sell it, NASA will negotiate an amortization schedule of the $100 million investment, for example 10 missions. If NASA leases the asset for the first time for 6 missions, the amortized portion of the lease price paid to the contractor is $60 million. Government cost of money and an appropriate fee also is paid.

However, the second time that NASA decides to lease the asset for 6 missions, current NASA policy permits NASA to pay only the remaining $40 million in lease fee for the unamortized cost plus the appropriate fee and government cost of money. If some other non-NASA user had leased the asset for three missions prior to NASA's second contract, current NASA policy is to not provide any lease fee because 100% of the company's investment would have been amortized through the first NASA contract and the non-NASA contract. This approach limits the profit available to the investor as before, even though the risk has increased because NASA's first contract does not completely pay for the cost of developing the asset. The investor is assuming the additional risk that another customer can be found or that NASA will have more requirements for the capability in the future.

When NASA is the predominant or sole user of a service or product, even fixed-price contracts are evaluated based on a build-up of cost which limits return on investment to the government cost of money with an appropriate fee. The $350 million saving received by the government is ***not*** considered when evaluating if the price is fair and reasonable.

There currently is no procurement practice that enables NASA to recognize the full $500 million value of the component that is being offered for only $150 million -- only the cost of producing the component is considered. Industry may require a profit as high as 50% ($150 million minus $100 million) to provide the appropriate compounded rate-of-return commensurate with the unique risks associated with space endeavors and the uncertainty of government contracting where contracts can be terminated for convenience or for lack of appropriated funds.

SPACEHAB Example

The SPACEHAB program required an investment of approximately $250 million to develop two flight modules and to provide integration services for the equivalent of four missions.

SPACEHAB raised over $100 million of private equity and debt to develop and produce the modules. NASA subsequently entered into a $184 million fixed-price lease contract with SPACEHAB to lease the assets and to payload integration obtain services for the four missions (the Commercial Middeck Augmentation Module or CMAM contract).

A NASA-funded study conducted by Price Waterhouse using NASA's own cost and pricing models concluded that NASA would have incurred a $1.2 billion expense to provide a service equivalent to that procured by NASA under the CMAM lease if NASA had used standard government contracting and practices to perform this effort.

SPACEHAB modules were build to, and have met, NASA's ICD and performance requirements and have flown successfully on each of the three missions to date.

NASA subsequently entered into another lease contract with SPACEHAB to provide logistics support for the Space Station Phase One Program to *Mir*. This contract is priced at $54 million for lease and integration services for the equivalent of three missions. SPACEHAB invested an additional $15 million to create a new Double Module that substantially enhances NASA's capability to carry supplies and equipment to *Mir*. By comparison, NASA is receiving twice the mass delivered to *Mir* at a price that is less than the incremental cost of the internally available capability.

Although both contracts with SPACEHAB are fixed-price, SPACEHAB's return is limited to the government cost of money plus a minimal allowable fee and an extensive documentation of expected costs was required. R&D was not recognized as a legitimate component of the lease price justification. SPACEHAB also is expected to lease the assets in the future at a price that eventually reaches zero because the historical cost of these assets will eventually be "amortized". The substantial savings documented by Price Waterhouse are not considered.

Recommendation

Commercialization can be promoted by focusing on the potential for investors to earn returns commensurate with the risks of the space industry. Many of the measures offered in the past to promote commercialization attempt to remove the downside financial risk by providing tax incentives or other inducements. These initiatives are valuable and welcome. However, the first factor considered by an investor is the amount of return that is possible in a new endeavor. It is only after the potential for return is acceptable that the investor looks for ways to limit risk and loss of capital. No amount of support will encourage investment if the loss of principal is possible and the potential rate of return is not appropriate. Investors make investment decisions based on how much they can potentially earn, not on how much they can afford to lose.

Therefore, by modifying NASA procurement practices, not regulations, industry can be encouraged to offer proposals to NASA for commercial space products and services that NASA can lease or purchase as needed rather than develop, own, and operate.

The fair price for commercially offered products and services can be determined through competition or by comparison with prices paid by other, non-NASA users. If NASA becomes the predominant or sole user of a commercial service offered by a single provider, an independent "should-cost" analysis can be conducted contrasting the price to be paid with the cost of providing the desired services in-house at NASA.

As defined in OMB Circular No. A-94 and authorized by FAR subpart 7.4, NASA can evaluate the value, rather than the absolute cost, of commercial proposals by conducting an independent "should-cost" analysis (such as the Price Waterhouse evaluation of CMAM) thereby promoting commercialization and achieving substantial savings when procuring space hardware and services.

In conclusion Mr. Chairman, I again would like to thank the Committee for the opportunity to appear today. I would be please to respond to any questions the Committee may have.

The CHAIRMAN. Mr. Frelk.

STATEMENT OF MR. JAMES FRELK, VICE PRESIDENT FOR GOVERNMENT OPERATIONS, EARTHWATCH, INC., LONGMONT, CO

Mr. FRELK. I'll try to be brief, Mr. Chairman. I know that we're running late in time.

On behalf of Earthwatch, Incorporated, I would like to express our appreciation to you, Mr. Chairman, and the committee for your vision and leadership shown in meeting the challenges associated with the establishment of a robust commercial space industry.

I speak with firsthand knowledge when I say that this committee's bipartisan work on the landmark legislation, the 1992 Land Remote Sensing Policy Act, provided the fundamental elements of a stable, predictable business planning environment for the fledgling remote sensing industry. That legislation responded to the needs of the private sector by simplifying the licensing and regulatory process, identifying in clear and explicit language what part of government had the lead responsibility for implementing the Act, providing stability and predictability by ensuring that the government could not capriciously withdraw licenses issued to the private sector. Also supporting a market based approach to defining commercially owned data, a departure from the traditional government view that all imaging data should be made available on a non-discriminatory marginal cost basis.

The dramatic results of this committee's efforts can be seen in a number of new ventures, Mr. Chairman, that have recently entered the space remote sensing marketplace. From Lockheed-Martin Space Imaging Corporation, to Orbview, Orbital Science's effort; to Boeing's Resource 21 effort and to GDE. Others are on the horizon. Earthwatch itself is the product of a merger between commercial remote sensing activities at Bell Aerospace and World View Imaging Corporation.

A partial list of our strategic partnerships, which is contained in the written testimony I've submitted and hopefully will get in the record, indicates the international nature of the space imaging business today. We have partners in Japan, in Hitachi, in Italy and in Canada in our business.

Our goal is to be the first to market as a premier global prerogative commercial high resolution satellite imagery and related geographic information products. Although we are building and deploying low cost imaging satellites we view ourselves as fundamentally an information and dissemination business. Thus, our main focus is on creating the digital globe, an information database made up of a range of imagery and geographic information products electronically delivered to the desktops of our customers in the future.

Being in the information services business means that the issue of intellectual property rights is an overriding concern to us in our dealings with the U.S. government. Issues related to procurement reform must be placed within a broader context of a major shift in the capabilities of the commercial space effort, vis a vis NASA. In the past the vast majority of NASA industry relations could be actively described as NASA being the dominant driving force in terms

of designing, managing the projects, providing resources, dictating the terms and conditions of the relationship with industry in a subordinate implementing role.

As far as the emerging commercial space imaging marketplace is concerned we are witnessing a significant reversal of that traditional agency/contractor relationship. In fact, we're not approaching government seeking public funds. In the case of Earthwatch, for example, we have the financial wherewithal, technology base and market expertise to approach the agency seeking an equal partnership arrangement based on mutual benefit.

There is no doubt that the concept of structuring contractual relationships with industry on an equal footing might be difficult for the agency's procurement and legal sections to accept. It is not easy to overcome nearly 40 years of practice. On the other hand, creative approaches to structuring partnerships between industry and NASA offers major advantages to both sectors in these fiscally strained times.

To put it in concrete terms, our industry would certainly benefit from access to some of the innovative work NASA has performed in areas such as data compression techniques, miniaturization of solid components, advancements in processing, just to name a few examples.

In turn, industry has the resources and capability to incorporate these technologies into the commercial space systems, thereby allowing government to generate maximum benefit with minimal public investment. Such benefits include NASA having the opportunity to have technologies deployed in the space environment and major budget savings with the commercial sector leveraging government technology and resources to generate new markets and jobs that in turn provide NASA with a robust constituency base.

In this context, many of my colleagues in the commercial space imaging business believe that NASA's Mission to Planet Earth offers a range of outsourcing opportunities for the commercial remote sensing sector that would produce major long term savings to the taxpayer.

In fact, the committee might even wish to consider in which ways Mission to Planet Earth is a test bed to facilitate private sector involvement. In this regard, we're very much encouraged by the committee's efforts to date to include funding in this year's authorization bill for evaluating and implementing mechanisms for innovative industry/government partnerships in Mission to Planet Earth.

I would like the committee to know that Earthwatch is a participant in an exciting NASA program. It's called the Earth Observation Commercial Applications Program and it has resulted in a very positive working relationship with the agency in terms of better defining the market potential from various remote sensing technologies. We believe it's worth exploring as a potential benchmark when looking at creative ways to incorporate the private sector into Mission to Planet Earth.

Again, coming back to data rights policies, this is a very important issue to a commercial industry like ourselves. We feel that the current policies in place relative to data rights will be an impediment for us to participate with NASA in some significant ways and

we need to work that with NASA and the committee to better understand how industry and NASA can move forward together.

As I stated again in my written testimony, I believe that the global positioning of satellite systems and services programs is an excellent model for how the public/private sector partnerships involving dual-use technologies can be successfully carried out.

There's been tremendous market growth in that area. We're projecting the same type of commercial market growth in commercial remote sensing. To achieve that goal will require constant vigilance and innovative thinking by all parties, including Congress. For example, we believe that the multi-year authorization of appropriations are crucial to providing the investment community a reasonable degree of confidence that the government as a customer for imaging products will, in fact, be a reliable partner over the long term.

In this regard, industry would not expect to be paid until satisfactory delivery of data. In cases where conflicts about the delivery of data over multi-year periods it is critical to be sure that payment, in fact, will be made. Perhaps Congress might consider set asides or some innovative mechanism to assure that the funds will be available when we in industry have fulfilled our commitment in producing the services or products the government needs.

Again, the Congress might wish to explore the creation of some sort of an ombudsman along the idea of NASA's. A lot of work has already been done in that regard. We're pleased by those steps. However, we think that maybe a more centralized role for the ombudsman would be important given the cultural differences even within NASA. As a result, we would recommend that maybe the ombudsman should report directly to the NASA administrator and to Congress and provide an annual report every year as to the progress by NASA in working with industry over those problem areas.

I would conclude at this point by saying that these are really extraordinarily exciting times for both the space industry and our government partners. The potential for this industry in terms of literally revolutionizing how space information is utilized at a consumer level is boundless.

Again, we're projecting this market for us to be, frankly, a $10 billion market by the year 2002. There are going to be up to 8-9 satellites up in space by the year 2000 doing commercial remote sensing. We believe that's a benefit to the economy as far as jobs and managing resources. We also believe that there may be benefits to the government's activities as well and we look forward to working with Congress and NASA in that regard.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Frelk follows:]

James J. Frelk
Vice President, Government Operations
EarthWatch, Inc.
Committee on Science
U.S. House of Representatives

November 8, 1995

On behalf of EarthWatch, Inc., I would like to express our appreciation to you, Mr. Chairman, for the vision and leadership you have shown in meeting the challenges associated with the establishment of a robust commercial space industry.

In the particular case of my industry, the commercial space imaging business, you and this Committee have provided the legislative support that has been critical to the emergence of EarthWatch, Inc., and other remote sensing ventures. We view today's hearing as the latest example of the Committee's ongoing efforts to highlight how the relationship between the private and public sectors can be significantly improved by streamlining the process by which the commercial space sector may provide government with low cost, innovative products and services; while the commercial sector benefits from leveraging access to federal customers and R&D.

I last testified before this Committee in my previous capacity as Director of the Commerce Department's Office of Space Commerce. Over the past several years, I have had the rather unique experience of seeing this industry from the vantage point of a government official, as well as an industry executive who struggles on a daily basis with the complex issues associated with building an international market base for our products. I speak with firsthand knowledge when I say that this Committee's bipartisan work on the landmark legislation, "1992 Land Remote Sensing Policy Act", provided the fundamental elements of a stable and predictable business planning environment for the fledging remote sensing industry. That legislation responded to the needs of the private sector by:

- Simplifying the licensing and regulatory process.
- Identifying in clear and explicit language which part of government had the lead responsibility for implementing the Act.
- Providing stability and predictability by ensuring that the government could not capriciously withdraw licenses issued to the private sector.

- Supporting a market-based approach to defining commercially owned data -- a departure from the traditional government view that all imaging data should be made available on a non-discriminatory, marginal cost basis.

In addition, Mr. Chairman, your efforts to assist industry by discouraging direct or indirect government competition with the private sector has also been extremely important to assuring the investment and customer communities that the Congress is seriously committed to fostering U.S. leadership in the commercial space imaging business. Your continued vigilance and support for industry in these efforts is critical and greatly appreciated.

The dramatic results of this Committee's efforts can be seen in the number of new ventures that have recently entered the space remote sensing marketplace: Lockheed-Martin Space Imaging Corporation, Orbview, Boeing's Resource 21, GDE Systems.

EarthWatch itself is the product of a merger between the commercial remote sensing activities of Ball Aerospace and WorldView Imaging Corporation. A partial list of our strategic partnerships indicates the international nature of the imaging business -- CTA, Inc., Hitachi of Japan, Nuova Telespazion of Italy, Datron Systems, MacDonald, Dettwiller & Associates of Canada, Technology Venture Investors (TVI), Burr, Egan, Deleage & Co.

Our goal is to be the first to market as the premier global provider of commercial high resolution satellite imagery and related geographic information products. Although we are building and deploying low cost imaging satellites, we view ourselves as fundamentally in the information dissemination business. Thus, our main focus is on creating *Digital Globe*, an information database made up of a range of imagery and geographic information products, electronically delivered to the desktops of our customers. Being in the information services business means that the issue of intellectual property rights is of overriding concern to us in our dealings with the U.S. government.

I strongly believe that the emergence of this industry is in large part due to the themes of transparency, stability and predictability which the Congress has brought to the various enabling statutes affecting telecommunications and remote sensing industries. And I further believe, Mr. Chairman, that this Committee should apply these very same criteria when seeking reform in all public policy areas, such as procurement, that shape the relationship between the private and public sectors.

To ensure effective procurement reform, it is necessary to place it in the context of the dynamic changes affecting our industry. As I stated earlier, it is important to understand that EarthWatch views itself as first and foremost as an information services company. As important as the satellite segment is to our business, we regard it as simply part of the infrastructure needed to meet the information needs of our international customer base. Accordingly, for us, issues related to intellectual property rights are paramount when considering entering into some form of procurement involving NASA -- such as our participation in the Clark satellite project.

Issues related to procurement reform must also be placed within the broader context of a major shift in the capabilities of the commercial space sector vis-a-vis NASA. In the past, the vast majority of NASA-industry relations could be accurately described as NASA being the dominant driving force (in terms of designing and managing the project, providing the resources, and dictating the terms and conditions of the relationship) with industry in a subordinate implementing role. As far as the emerging commercial space imaging marketplace is concerned, we are witnessing a significant reversal of that traditional agency-contractor relationship. In fact, we are not approaching government seeking public funds. In the case of EarthWatch, for example, we have the financial wherewithal, technology base and market expertise to approach the agency seeking an equal partnership arrangement based on mutual benefit.

There is no doubt that the concept of structuring contractual arrangements with industry on an equal footing might be difficult for the agency's procurement and legal cultures to accept (it is not easy to overcome nearly forty years of practice). On the other hand, creative approaches to structuring partnerships between industry and NASA offers major advantages to both sectors in these fiscally constrained times. To put it in concrete terms, our industry would certainly benefit from access to some of the innovative work NASA has performed in areas such as data compression techniques, miniaturization of satellite components, advances in signal processing -- to name just a few such examples.

In turn, industry has the resources and capability to incorporate these technologies into their commercial space systems and thereby allow government to generate maximum benefits with minimal public investment. Such benefits include NASA having the opportunity to have technologies deployed in a space environment at major budget savings, with the commercial sector leveraging government technology and resources to generate new markets and jobs that, in turn, provide NASA with a robust constituency base.

In this context, many of my colleagues in the commercial space imaging business believe that NASA's Mission to Planet Earth (MTPE) offers

a range of "outsourcing" opportunities for the commercial remote sensing sector that would produce major long term savings to the taxpayer. In fact, the Committee might even wish to consider ways in which MTPE might be used as a test-bed for procurement reform to facilitate private sector involvement. In this regard, we are very much encouraged by the Committee's efforts to include funding in this year's authorization for evaluating and implementing mechanisms for innovative industry-government partnerships regarding MTPE.

We believe that such study efforts will greatly assist NASA and the Congress in understanding the potential for significant savings from MTPE partnerships with industry. I would like the Committee to know that EarthWatch is a participant in an exciting program at Stennis Field Center -- the Earth Observation Commercial Applications Program (EOCAP). It has resulted in a very positive working relationship with the agency in terms of better defining the market potential for various satellite remote sensing technologies. We believe it is worth exploring as a potential benchmark when looking for creative ways to incorporate the private sector into the MTPE.

One of the major impediments to achieving innovative partnerships between NASA and industry pertains to the data rights issues that I alluded to above. The normal presumption under NASA contracts is to make all data generated under the contract available to all at the marginal cost of reproduction. This "open door" policy is anathema in the commercial world where the value of data is defined by the willingness of the marketplace to pay for it.

As I stated above, our company is in the information business. Accordingly, our model for making data available is patterned after the long standing practice of the software industry to issue site licenses, as well as seek protection of distribution of data to third parties without the approval of the software owner. For example, when NASA buys a commercial software package it is precluded from making it available for free or at some arbitrarily defined marginal cost to the public-at-large.

There is absolutely no reason why the agency's procurement practices should not incorporate the same standards when entering into partnerships with the commercial space imaging industry. In fact, left unresolved, this whole data rights issue will continue to represent a fundamental impediment to the ability of our industry to provide NASA and other agencies with the cost-savings and innovation that will naturally come from a competitive commercial space imaging industry. In recognition that there are no "overnight" fixes, I would propose that NASA and industry focus on identifying pilot projects that could act as showcases for demonstrating how

commercial practices might be introduced into various data rights arrangements with the agency.

In my view, the Global Positioning Satellite (GPS) program is an excellent model for how public-private sector partnerships, involving dual use technologies, can be successfully carried out. As you know, GPS was originally a Department of Defense (DOD) funded project intended to respond to primarily military requirements in the areas of navigation, tracking and location. When the U.S. government allowed the civil users access to GPS, the marketplace literally exploded. Today, the GPS is approximately $1.26 billion, of which DOD-related uses make up a comparatively modest market of $70 million. By the year 2000, it is anticipated that the total GPS market will represent $8.4 billion, of which the military market will represent $130 million.

The product cycle time in the GPS industry is typically 12-18 months (less than 12 months for software). I need not remind this Committee that it is not unheard of for a government procurement process to take as long as 1-2 years. They key to the remarkable growth of this industry sector and its obvious benefits to its original government agency sponsor (greater product differentiation at significantly reduced costs) was what will be critical to the growth of my industry -- policy stability and predictability.

When considered as part of the remarkable rapid growth of the Geographic Information Service (GIS) marketplace (today's market is estimated at $5 billion and is projected to grow to $10 billion by 2002), the commercial space imaging business could well demonstrate a similar growth pattern -- with comparable benefits to NASA that the GPS industry is providing to the DOD world.

To achieve that goal, however, will require constant vigilance and innovative thinking by all parties, including the Congress. For example, multi-year authorization/appropriations are crucial to providing the investment community a reasonable degree of confidence that the government as customer for our imaging products will, in fact, be a reliable partner over the long term. In this regard, industry would not expect to be paid until satisfactory delivery of the data. In cases where contracts involve delivery of data over a multi-year period, it is critical to be assured that payment will, in fact, be made. Perhaps Congress might consider set-asides or some innovative mechanisms to assure that the funds will be available when we in industry have delivered the data product as agreed upon. Being able to assure one's investors and customer base that the funds will be available upon delivery of the product would make the government commitment "bankable" and assist in securing the private capital necessary to bridge the period covering the performance of the contract.

Congress might also consider directing the agency to explore the use of "data vouchers" -- perhaps again on a pilot project basis -- that would empower the research community to "shop around" for their spacecraft of choice. This is an example of how the agency benefits from working in partnership with industry to foster low cost commercial alternative access to deploying space payloads.

In addition, Congress might wish to explore the creation of some sort of ombudsman entity in NASA. I understand that the procurement office at NASA has created an ombudsman type function at Headquarters and the various Field Centers. I think that is a terrific step forward. However, one of the difficulties faced by commercial entities is that the agency is composed of diverse offices with sometimes competing cultures and agendas. Accordingly, it might be useful to have an office that reports directly to the NASA Administrator and is accountable to Congress and could assist the commercial space business in resolving issues in an expeditious manner. Such an ombudsman, with agency-wide purview, might be required to provide the Congress with an annual report identifying progress associated with NASA-industry partnerships and outstanding issues that need resolution.

Finally, this Committee would be well served by reviewing some of the innovative practices employed by other technology agencies and program offices, such as ARPA and BMDO, in their various joint ventures with the commercial sector.

I will conclude at this point by saying that these are extraordinarily exciting times for both the space imaging industry and our government partners. The potential for this industry, in terms of literally revolutionizing how spatial information is utilized at the consumer level, is boundless. Although there will be tough issues ahead as we in industry and government work to reshape and redefine four decades of old ways of doing business together, with this Committee's continued support, the end result will be a partnership that will ensure U.S. leadership in this new marketplace in the years to come.

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The CHAIRMAN. Mr. Rogers.

STATEMENT OF MR. TOM ROGERS, ADVISOR TO THE SPACE FRONTIER FOUNDATION, PRESIDENT, THE SOPHRON FOUNDATION, MCLEAN, VA

Mr. ROGERS. Mr. Chairman, members of the House Committee on Science. The United States should have two strong private sector space business areas. Unfortunately, we have only one. Business in the information area—primarily satellite communications—is booming. Revenues are rapidly approaching $10 billion a year at a 10-15 percent per year rate.

But there is very little business in the so-called "manned space" area. The reason for this is the enormous unit cost of basic space infrastructure. Compared with its cost at the surface, electricity in low Earth orbit costs 1,000 times as much, and work in space costs 100,000 times as much. A Shuttle trip there costs 10,000 times a TransAtlantic airfare.

There will be no large scale commercialization in the manned space area until these paralytic unit costs are reduced by orders of magnitude. We've all known for some time that these costs can be greatly reduced but getting them down continues to be a vexing matter to those of us who want to see space activities make a much larger contribution to our economy.

Why? Well, for decades hardly anybody cared. Manned space was a government preserve, one to be devoted almost exclusively to science and exploration. Wealth was meant to be spent on space. Space was not expected to be used to create wealth.

Now, while this attitude is changing, we face two grave problems. NASA and our aerospace companies build very high cost assets for government use under political ground rules, not economic ones. Because of this, and the enormous infrastructure costs, no large private sector manned space markets have been or can be created.

What can be done to change this parlous situation? A revolutionary concept should be embraced. We should now begin to use the Space Station program and market research to move away from a planned economy toward a free enterprise economy. All of the goods and services of the United States' portion of the Space Station should be privatized by United States companies with the clear objective of driving down their unit costs, sharply and soon.

Market research should begin to receive important attention as costs come down and companies gain LEO experiments. And, as the possibility of doing wholly new things in space is demonstrated, I am absolutely convinced that commercial businesses involving people in space will burgeon.

Today, the best way to visualize the space station is that offered by the Space Frontier Foundation. It should be thought of as our first town in space. Once the Space Station is assembled the program's primary and continuing emphasis should be to see this space town, Alpha town, grow and prosper.

Making such fundamental conceptual and business operational space changes will not be easy so I'm going to make you eight specific suggestions:

One: Space Station commercialization language such as that in the Rohrabacher amendment to this year's HR 1601 bill should become law. And compliance with this law should be a constant concern of this Committee.

Two: all Space Station international agreements should be reviewed immediately to see that they allow for the United States' privatization of all Station U.S. goods and services.

Three: if a private contractor is to operate the space station it must be explicitly committed to seeing imaginative, energetic and cost reducing companies chosen to privatize its goods and services.

Four: the Congress should allow public funds to be used in pursuit of space station privatizing contracts.

Five: our balanced civil space program should be unbalanced to the extent required to see the highest priority placed upon the sharp and early reduction in space transportation costs.

Six: NASA should begin to treat market research with an importance equivalent to that of scientific research. And Shuttle and Space Station capabilities should be made available for market related studies.

Seven: the suggestion made at last week's X33 hearing that a Board be created to consider X33 follow on vehicle financing issues should be given prompt and favorable consideration.

Eight, and finally: the NASA Administrator should broaden his Advisory Council by drawing in people from without the space area who are broadly experienced in business matters.

Mr. Chairman, thank you for inviting me here today.

[The prepared statement of Mr. Rogers follows:]

Statement to the:

Committee on Science

U. S. House of Representatives

By:

Thomas F. Rogers

Advisor to The Space Frontier Foundation

and

Chairman of The Sophron Foundation

November 8, 1995

At the outset I must note that I am not speaking here today to any commercial space activities in the information areas of communications, navigation, position-fixing or remote sensing. I will focus upon so-called manned space activities in general and the Space Station Program in particular, and how the Program could facilitate the "commercialization" of space

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A dozen years ago I directed your Office of Technology Assessment's (OTA) Space Station study.

For a decade, it stood the test of time.

But now it is clear to some of us that we should look upon our publicly funded Space Station Program in quite a different light than in the past. For:

- Our Country's social, political, and economic circumstances are now quite different;
- The Federal civil space program is in substantive difficulty; and
- New technological options begin to present themselves

But perhaps the most important aspect of the manned space area of civil space has been its ***resistance to fundamental change:***

- It has essentially failed to create wealth while spending great amounts of it; and
- The American general public has been kept from participating directly and personally in space activities — the citizens of the world's greatest democracy are only allowed to observe.

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I would like to offer you two different Space Station Program scenarios — one Pessimistic, and one Optimistic, in order to lay out a context for thinking about desirable, indeed, in my judgment, mandatory changes in the Program.

In each case I ask you to project your thinking about our space circumstances ***to the year 2012***. That year would mark the conclusion of a decade's operation of the fully assembled Station — an interval which is now taken to be, in effect, its politically acceptable lifetime.

In each case I assume that:

- The Program proceeds on its present time and cost schedule, and the 13-country International Space Station (ISS) coalition remains intact,

- For that decade of full use, the Space Station provides the capabilities expected on it, and

- The Federal civil space program fiscal circumstances now being projected are, in fact, experienced.

The ***Pessimistic Scenario*** for the year 2012:

- The views of our general public toward so-called manned space remain as they are today: continued general interest but a small effective constituency because what the government chooses to do in space is simply not important or interesting to much of the general public;

- Even with small appropriations reductions and inflationary increases, each averaging 2-3% per year, the purchasing power of NASA's space budget 17 years hence is down to roughly 1/2 of FY 1995's, to some $6 billion per year;

- The X-33 program has long since "stalled out" — not for technological or operating reasons but because large enough private sector and government service markets could not be confidently foreseen, and therefore private sources would not advance the large capital amount needed to acquire a commercial vehicle-fleet;

- Shuttle trips have been cut back to four per year, and the minimum amount has been spent on the fleet to keep its operations safe and acceptably reliable;

- Working as hard as they can, the three U.S. people manning the Space Station simply cannot do enough work under the circumstances to achieve important scientific and/or technological breakthroughs of multi-$ billion proportions;

- The cost to the U.S. of operating its portion of the Space Station, and the Shuttle fleet, and supporting Station experimental programs — in total some $5 billion per year — consumes nearly all of the NASA budget, thereby costing it constituents in much of the aerospace industry and scientific community generally;

- Therefore, the Space Station is closed down;

- With the loss of the Space Station's service market, and because of its continuing great operating cost, the Shuttle fleet is also closed down;

- A modest civil space scientific program continues, but the manned space activities expected to blossom in the 1960s and 1970s comes to an end;

- The Lief Erickson era is over, and the U.S. space enterprise settles down to await a "Christopher Columbus" in the far future;

- Meanwhile, Japanese space business interests, having focused specifically upon serving a large commercial space tourism market, now leads the world in space.

In short, a sad and frustrating demise of our civil and commercial space aspirations — a Scenario that, under today's policies and projections, and in spite of all of our intellectual and physical space resources and operating experience, may well be realistic.

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At this point, Mr. Chairman, we must remind ourselves of the outstanding characteristic of manned space activities: their enormous, even brutal, cost:

- LEO electricity now costs 1,000X more than that at the surface;

- To see a person travel to-from LEO, the government must pay 10,000X what one pays to fly across the Atlantic Ocean; and

- The cost of habitable volume in LEO is expected to be 100,000X that of commercial space in large urban areas.

All of us who have a serious interest in America's future in space must remind ourselves every day that our Country's highest space priority must be to get the unit cost of basic space infrastructure, especially space transportation, down by orders of magnitude.

It doesn't matter what else we do in space, if we do not reduce our unit space infrastructure costs, sharply and soon, our future space prospects will be drastically diminished!

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Before advancing an alternative Scenario, let me provide a much different view of the Space Station Program.

About two years ago the "Commercial Space Transportation Study" (CSTS) of the aerospace company "Alliance" first suggested the creation of a free-standing, private sector, Multiuse Low-Earth-Orbit (LEO) Space Business Park. Earlier this year, Mr. Chairman, you suggested in a talk to the Space Transportation Association (STA) that, in effect, the publicly funded Space Station should be considered to be the physical and institutional centerpiece of such a Business Park.

Now the Space Frontier Foundation has amplified these concepts by suggesting that Space Station "...Alpha can and must become the heart of...a new town on the frontier of space."

Because the "Alpha Town" concept is so new, let me describe its basic thrust here. (A piece in *Space News* that describes the Space Frontier Foundation's concept in more detail is included here in an Appendix.)

There is ample historical precedent for the expansion of a national frontier being catalyzed by government action. Throughout Europe there are cities that were born outside the gates of Roman feudal facilities. Our own West is filled with towns that also grew outside the gates of U.S government forts.

These facilities first and foremost were a national statement of confidence in the areas under their "jurisdiction," so to speak. Citizens (read. "investors") could count on the fact that the areas in these domains would have some modicum of stability, that it would be in the interest of that nation to secure and maintain transportation routes and that the facility itself would provide the nexus for early market growth.

The Space Frontier Foundation believes that this is the only justification for the international Space Station that is supportable in the long term by the American people

The Alpha Town concept creates an overarching new mindset for the entire human space program in LEO that is easy to understand and to explain, and creates a new mindset for human space activities. Whereas many Station proposals deal with the "how" when it comes to private and commercial activities, the nation has not yet bought the "why" in this context. Alpha Town answers this question. It comes directly from our American heritage and feeds directly into our national hunger for a purpose in the new millennium.

Although business parks are an important part of any town, they are only one aspect of it (for example, one rarely finds tourist hotels in business parks) and they cannot be the centerpiece of any compelling vision that the American people can get behind.

The Space Frontier Foundation believes that it is imperative that this new mindset be adopted. If it is, and the terrestrial "town" becomes our model, then the *reason d'être* of the Station will become clear to all Americans. Using the town model so familiar to legislators and business people, the institutional, regulatory and financial tools and incentives one might apply to encourage economic growth here on Earth immediately suggest themselves, and can be applied to this new domain.

You should know that the Alpha Town concept does not call for any change in the configuration of the Space Station or the Program's schedule or cost. Rather, it does urge that.

- All U.S. government needs for surface-Station people and cargo transportation be provided by private U.S. firms;

- The recycling and further use of all hardware brought up to space — such as the Shuttle's external tanks (ETs) — be emphasized; and

- There be no more publicly funded Station capital expenditures — that any additional assets and services be provided to the government by private U.S. businesses on a lease basis.

That is, the Space Station program should be thought of as playing a vital "banking" role over a transitional interval to help move the manned space area from being one of a publicly funded planned economy to one in which competitive, profit-seeking free enterprise activities flourish. That is, a U.S. Space Station government assets and services would be "privatized" so that companies could obtain needed private sector experience, and establish credibility and cash flow. Doing so would see the cost of space-related goods and services drop to the point where true "commercialization" could commence.

In this modern context, then, let me offer you an *Optimistic Scenario*, for the year 2012:

- A large number of low unit cost private sector residential and working volumes have sprung up at or close by the Space Station;

- It has much more electrical energy and wide-band radio communications capacity;

- A new commercial surface-LEO reusable fleet has been employed in a fleet numbering several 10s of vehicles for nearly a decade, and a new vehicle is under development that promises even lower cost operation;

- Space sports and space tourism are particularly flourishing businesses among many others presented in the IEEE and "Alliance" economic space reports;

- New sports records have been established and wholly new kinds of sports are being conducted that attract large numbers of players and world wide audiences of 10s of millions;

- The space tourism business well exceeds $10 billion per year, with some half-million people visiting space each year, a large number of whom enjoy a short stay in a LEO hotel;

- The government's cost of operating the Space Station is less than 10% of the figure expected in 1995, and is on its way down to a very few percent;

- Much of the private sector habitable volume is devoted to publicly and privately funded microgravity research laboratories that already support over 100 scientists and technicians therein — professionals who have seen some of their number considered for Nobel prizes, and whose work has had demonstrably large economic value, especially by reducing government Medicare and Medicaid costs;

In short, public and private manned activities are burgeoning. Large numbers of new businesses and private sector jobs have been created, our tax base has been enlarged, our international competitiveness has been strengthened; and our balance of payments favorably increased, And large numbers of our general public are directly and personally involved in commercial-industrial space businesses and activities, and the general public is once more an effective civil space constituency.

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What will it take to experience something like the Optimistic Scenario?

Primarily four things:

- A recognition that, under presently foreseeable circumstances, our civil space program and, therefore, many of our space aspirations — cultural, economic and political — are now clearly in jeopardy;

- A national determination that we are going to prevent this from happening by seeing the program changed;

- A policy focus primarily upon private sector rather than public sector goals by the Congress and the White House; and

- A program focus by NASA and our aerospace industry upon sharp and early unit cost reduction of basic space infrastructure — especially surface-LEO space transportation — and large new market creation.

More specifically:

- Language speaking to the commercialization of the U.S. portion of the Space Station Program, such as that accepted by the House of Representatives in Rep. Rohrabacher's amendment to the multi-year Space Station authorization bill, should become law;

- Steps should be take immediately to review all of our formal agreements with other countries and their space offices *re* the Space Station to see that they provide for full U.S. private business provision of the U.S. portion of the Station's goods and services — our Space Station agreements context should now begin to be as much economic as political;

- In NASA's consideration of any prime contractor to operate and maintain the Space Station after its assembly, great care should be taken to see that a government bureaucracy is not replaced with a like-minded government-tutored organization having little stomach for imaginative, fast paced, reduced cost, entrepreneurial activities;

- In order to see that the most imaginative, energetic and fast-moving entrepreneurs, who in the nature of things are oftentimes to be found in smaller and younger companies, are able to compete with the very large "classical" aerospace companies, the "playing field" must be kept level by the government prohibiting the use of any public funds available to the latter in any activity that they mount to obtain "privatization" contracts;

- We should stop calling for a "balanced" civil space program immediately; while we do not need to spend any more public funds on civil space than we are today — $12-13 billion/year is a very large sum, indeed —we must focus whatever funds are needed upon reducing the unit cost of basic space infrastructure, sharply and soon, and upon opening up large new private sector space activity markets;

- Basic market research (N.B., *Not* specific product research, which must be done by companies) should begin to be pursued by NASA with as much vigor, imagination and commitment as in basic scientific research today; professional market research studies should be funded by the government and experimental market research studies should begin to be carried on in the Shuttle fleet very soon and on the Space Station as soon as possible thereafter;

- J. S. Gordon's suggestion made at last week's X-33 hearing — that a Board be created to consider X-33 follow-on commercial vehicle financing issues — should be given prompt and forceful consideration; and

- The NASA Administrator should re-balance his advisory structure — at least one-half of the persons who make up the NASA Advisory Council should be brought in from without the space area, many from non-aerospace companies.

All of these steps should be taken quickly in order that important time not be lost and so that space business interests in other countries are not allowed to narrow our initial advantages.

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Mr. Chairman and other Committee Members: In the space area I grew up professionally in satellite communications and navigation. Now our satellite communications business sector is burgeoning and our satellite navigation business is also growing rapidly.

I am absolutely convinced that there is the potential for at least as much business activity involving people in space as there is in the information area.

And I am just as convinced that the Space Station Program, enlarged and modified to embrace the Alpha Town concept, and an enlightened U.S. business-Federal government partnership over a transitional interval of a decade or so, will see us lay a sound base for

realizing such a great economic gain — which will, of course, have great social implications and add immeasurably to our national security.

Finally, with the attendant sharp infrastructure cost reductions and the resurgence of general public interest in space, then we can turn with confidence to further exploration of our solar system and the beginning of its settlement.

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Appendix

Reprint of an article entitled "The First Human Town in Space" in *Space News*, October 9-15, 1995, page 15.

Alphatown

The First Human Town in Space

Rick N. Tumlinson — President of the Space Frontier Foundation

The irony is incredible. After more than 30 years, space should be the leading edge of the American dream, a thriving economic and social arena, a place of hopes and vision for all humanity. But this is not so and may never be. Rather, space is perceived as an expensive and irrelevant luxury. The reason is simple — our space program is not and has never been designed to open the frontier.

Even now, some plan to spend millions to repackage the current Cold War program and sell it to the American people.

They will fail.

There is no way to sell the public on it. It is like trying to sell badly made American cars in the 1970's, by increasing Madison Avenue advertising — rather than making a product people want to buy

It is the space product that is wrong, not the package. People are not buying it because they are not stupid, they are not excited, they are not included and they do not see where the program is going.

Because of this, support dwindles, and those who paved the path from the plains to the stars just don't get it.

The answer is obvious and powerful: Let the people go. Opening the frontier to everyone must be the new U S. national goal in space NASA must be transformed so that its primary mission is supporting U.S. space enterprises. In other words, the government's role in space must be to help Americans begin their new national mission, the settlement of space. And as the centerpiece of that new program we must change Alpha

Most people see the international space station Alpha as having no real purpose other than to exist. We must give it a purpose that is simple, obvious and not based on the constituency of the month.

The effect of government facilities on frontiers is obvious. They provided the nuclei for settlements by creating demand for goods and services. Transportation routes for frontiers

were established or improved at government expense, and the governments' official demonstration of confidence in their expanded dominion gave people who might invest in the wilderness psychological permission to go for it.

If the space station is to be relevant to our future, Alpha can and must become the heart of just such a new town on the frontier of space

Weary station workers must keep in mind that no redesign lurks here. The Space Frontier Foundation proposes no changes to the current station's layout and assembly. However, we do want to change how the station is used and how it will grow. We propose the following:

- After completion of the assembly phase, all U.S. government transportation needs for the station — flights to and from Alpha — will be competitively provided by private U.S. firms.

The government's new role in space will be to use its purchasing and regulatory powers to catalyze the creation of a transportation corridor. There will be no more national space ships. The new commercial space shuttle managers should be given title and rights to do with them as they please, but not as sole sources, as they must compete for Alpha payloads with other commercial U.S. .systems. Also, the priority of NASA's X-33 Reusable Launch Vehicle effort must be raised to the top level in the administration, and not just rhetorically. Funding must be increased immediately, goals must be raised and schedules shortened.

- The government will put in place legislation to encourage actively the recycling and development of usable volume in space.

Every usable piece of volume-creating hardware that is carried into space will become an instant asset, with cash value, even if on Earth it would be expendable. We must create legal and financial incentives resulting in the recycling of such materials. For example, if people can salvage even one of the giant shuttle external tanks it would drastically increase the usable assets in orbit. In the same vein, Boeing is to be commended for its farsighted plan to keep Russia's Mir space station operating privately after Alpha is begun. Whether orbital real estate is recycled or built and launched, we must encourage such entrepreneurial spirit and apply very successful terrestrial real estate models like tax abatements, tax free zones, investment credits and other incentives at the start, to lure companies to build.

- All expansion of physical structure of the U.S. portion of Alpha will be commercially leased from U.S. private firms, preferably off site.

Since the goal is not to grow an expanding federal building in space, the government's need for volume beyond the initial phase of the space station should be accommodated by leasing facilities from private firms. NASA must reverse its fear and loathing of such

projects. Instead of killing other approaches to using space, NASA managers' jobs will be to seed, nurture and crusade for them.

Prospects for expanding Alpha go far beyond the boring image of an industrial park in space. There are many proposals for building hotels and tourist facilities in orbit to serve a huge market. Towns are much more than just their industrial bases, and Alpha Town can be no different.

- All additional energy requirements aboard Alpha after assembly is completed will be met by commercial vendors, preferably off site.

Alpha's energy needs will grow, and new facilities will also need power. These demands converge with the opportunity to explore and develop what may become Alpha Town's equivalent of striking oil or gold: space generated power, beamed to the user. Alpha will be the first test bed, then possibly a customer. As the technology becomes routine, commercial operators of solar power satellites may well decide to pursue the terrestrial energy market. At that point people will have hit the jackpot, and the frontier will be open.

Remember, the Alpha Town concept is not about hardware. It is about a mindset. The details are irrelevant. The particular technologies do not matter. It is not a destination or a facility, it is an intellectual framework upon which we build the reality of human space settlement. It takes the American people from their couches as passive observers of a set of government stunts and creates a plan to put them in the driver's seat.

If Alpha Town is not adopted there will be no reason to have a federal building in space. And if, as in the past, the reality is stripped from the rhetoric and business as usual continues with the government either controlling or killing all human space activities other than its own — we can kiss the frontier good-bye for another 30 years.

If adopted as a real goal, Alpha Town will soon be a growing and vibrant community. It will be a gleaming star of opportunity for Americans and all the people of the world, twinkling overhead in the night, and anyone wondering where this nation is going will only have to look up to see the answer.

The CHAIRMAN. Thank you, Mr. Rogers.

Before proceeding to questions I'd like to submit, without objection, a couple of items for the record. The American Bar Association's analysis of NASA's proposed rule on cooperative agreements with commercial firms, and an article from Rolling Stone magazine, April of '95, on the new Mission Control Center at Johnson.

[The items referred to follow:]

Exhibit T-4

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Subject: Proposed NASA Rule on Cooperative Agreements with Commercial Firms, 60 Fed. Reg. 33136

Dear Mr. Deback:

On behalf of the Section on Public Contract Law of the American Bar Association (the "Section"), I am submitting comments on the above-referenced matter. The Section consists of attorneys and associated professionals in private practice, industry and Government service. The Section's governing Council and substantive committees contain a balance of members representing these three segments to ensure that all points of view are considered. In this manner, the Section seeks to improve the process of public contracting for needed supplies, services and public works.

The Section is authorized to submit comments on acquisition regulations under special authority granted by the Association's Board of Governors. The views expressed herein have not been approved by the House of Delegates or Board of Governors of the American Bar Association and, therefore, should not be construed as representing the policy of the American Bar Association.

The above-referenced matter will establish NASA requirements for cost-shared cooperative agreements with industry, to complement NASA regulations for cooperative agreements with educational institutions and non-profits at 14 CFR 1260. We commend the sections of the proposed regulation that will allow flexibility and minimize administrative requirements for these collaborative agreements. These sections include:

1) application of generally accepted accounting principles, instead of government cost accounting standards, for accounting for expenditure of funds (1274.919);

2) the mutual right of revocation when it is in the interest of either party to the agreement (1274.701);

3) blanket authorization for allowability, as cost-matching by recipients, of IR&D expenditures reimbursed under government cost-reimbursement contracts (1274.102, citing 48 CFR 1831.205-18);

4) the requirement of NASA to notify the recipient when a NASA technical support contractor will be supporting NASA's efforts under the agreement (1274.903), which might result in conflicts over rights to subject inventions;

5) a simplified disputes procedure (1274.907);

6) less frequent filings of required certifications and representations, where permitted by statute or regulation (1274.205(e)); and

7) no automatic requirement of cost or pricing data in proposals, and no requirement for certification of such data (1274.204(d)).

We offer the following suggested improvements to allow even more flexibility and less administrative requirements. These improvements are also appropriate because, in most cases, industry will provide at least 50% of the funding for most of the cooperative agreements under this regulation:

a. 1274.202(b): Unsolicited proposals. The rule proposes CBD notice similar to that found in the FAR, of cooperative agreements "awarded" as the result of an unsolicited proposal. CBD notices of cooperative agreements are not required by any statute or regulation, and are particularly inappropriate for cost-shared R&D. This may result in other entities learning the commercial research aims of the submitter, and give competitors the opportunity to submit competing proposals, thus discouraging submission of innovative proposals from industry.

b. 1274.202(c): Allowability of costs will be determined based on FAR cost principles. There is no statutory requirement for the application of FAR (or OMB) cost principles to cooperative agreements with commercial entities. Applying these automatically to commercial companies that do not normally enter into cost-reimbursed contracts with NASA will require such companies to establish special accounting procedures to track the costs of the collaborative effort. We recommend the regulation permit alternatives, e.g., an advanced agreement permitting more flexible tracking of costs, such as a percentage disallowance of indirect costs in lieu of item-by-item

tracking of costs. If necessary, NASA should seek OMB approval of such efficient alternatives for cost-shared cooperative agreements.

c. 1274.203(h)(2), "Data Rights," provides, in part, that after a "reasonable time period" of "two to seven years depending on the technology," "data rights will be made public" to "ensure that the Recipient is not established as a long-term sole source supplier of an item or service and is not in a position to take unfair advantage of the results of this cooperative agreement." This statement should be removed. Apparently, it is addressed to all data rights. It is not required by law or regulation, nor helpful to meet future government requirements (the government will obtain at least a royalty-free license to use "subject inventions" arising from the agreement, per 1274.912). In addition, this statement contradicts (h)(6), which protects for the recipient's use, for up to five years, of "confidential" data generated by NASA under the collaborative effort. Also, this statement contradicts the required "Rights-in-Data" clause at 1274.905 that provides virtually unlimited protection of Recipient "background data," and extensive protection of "data first produced by Recipient" under the agreement.

d. 1274.202(c)(3) and (4), "Cost and Payment Matters:" Payments will be made based on "fixed amount" "milestone billings" negotiated before award, and based on cost estimates submitted by the awardee. In addition, however, section (c) requires submission of invoices for each milestone. Because the price for each milestone is fixed, and milestone payments are made only when the milestone is met, we recommend less frequent submission of invoices, perhaps on a quarterly basis, or even at the conclusion of the agreement. In the meantime, the government's interests are protected by the milestone requirements, and paperwork and administrative expenses are reduced.

e. 1274.501, "Subcontracts," requires that all subcontracts, including small purchases, contain the procurement provisions of Appendix A "as applicable." However, it appears that most of the subcontract provisions are required only if the prime agreement is a procurement contract. Because this proposed regulation concerns "cooperative agreements" as described in the Chiles Act, such provisions are not required in the awardee's subcontracts. Though this proposed regulation requires the subcontract provisions only "as applicable," NASA should determine which subcontract provisions are required by statute, and require only those provisions in recipient subcontracts.

f. 1274.915, "Restrictions on Sale or Transfer of Technology to Foreign Firms or Institutions." This provision requires notice to NASA of proposed transfers to foreign firms of technology developed under the agreement, and NASA may determine whether the transfer "may have adverse consequences to the national security ... or to the establishment of a robust United States industry." The criteria for NASA's determinations should be specified. Also, the required notice of a proposed transfer should be to the "grants officer" rather than the "contacting officer."

g. 1274.912 and 1274.913: Patents. The flow-down requirements for patent clauses in subcontracts need to be clarified. In each of these clauses, patent provisions are required to flow down to all subcontracts -- the definition of "contract" includes "any ...subcontract ...." These definitions should be amended to correspond with 1274.905(d), "Data Rights," which limits flow-down requirements to lower tier agreements "for experimental, development or research work."

The Section appreciates the opportunity to provide these comments and is available to provide additional information or assistance as you may require.

Sincerely,

Frank H. Menaker
Chair, Section of
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LOST
SPACE
OUTLAW ENGINEERS ARE
STRUGGLING TO SAVE NASA
WITH A NEW GENERATION
OF SECRET TECHNOLOGY

A CONCRETE ROOM off Building 30's entrance, a guard with a gun gave me an ID badge and a four-digit code. We crossed the lobby, and I had to stick my hand inside a dark box and enter my code on a touch pad while a sign instructed me to look into the mirror and a camera scanned my face. A shiny steel door swung open. I was in. ★ A sign inside said WARNING! THIS IS AN OPERATIONS SYSTEM USED FOR SPACE SHUTTLE SUPPORT. DO NOT TOUCH ANYTHING! In this building, which is painted the color of uncooked pasta and smells like a school cafeteria, the business of Mission Control has gone on since the Gemini and Apollo days. ★ I plunged through corridors of humming equipment. Everywhere old green steel cabinets full of antique wiring were being ripped out and replaced by smaller, molded sculptures of lustrous plastic filled with integrated circuits. At no time in history will the revolution that is going on inside NASA be more evident than it is now, in the guts of the Control Room. ★ On one side of a great cavernous room were the old-fashioned telephone-patch bays, a Medusa of wires curling to the floor, dozens of quaint silver computer-tape reels nervously stopping and starting, wooden skids of spent tapes stacked around, miles of paper spewing from immense line-printing machines, downlink monitor numbers clicking over on the shabby monochromatic screens cased in steel like old Army-tank parts. ★ On the other side of the room were new high-speed disk drives, robotic 85-gigabyte tape-cassette machines and brilliant color monitors screaming with a faint supersonic whine through train loads of numbers. The 1.2-terabyte "jukebox" contained the recorded data from every shuttle mission ever flown, all stored on optical disks in this Sony Writable Auto Disk changer. A group of seven boxes, each 4 feet tall, had replaced an entire building full of tapes. ★ I couldn't help wondering if the astronauts in the shuttle mission STS-59, which at that moment was flying 120 miles up over Lake Superior, understood that their delicate craft was being buoyed aloft as this tangled gob of wire was being reconstructed like a heart-transplant patient going under the knife while the operating room is rebuilt around him. ★ Escorted by John Muratore, I passed among the scores of people working control- and technical-back-up positions. In the revolution that has been quietly taking place at NASA, Muratore is the Che Guevara. Now 38, Muratore started his campaign more than a decade ago when he discovered that his home laptop could do things that Mission Control's computers could not. But the putsch turned into a desperate effort to rescue the space agency from extinction. To that end, Muratore and a handful of young engineers who called themselves the Pirate team waged an unrelenting and clandestine guerrilla war against the bloated and stultifying NASA bureaucracy. The Pirates literally had to tear apart the computers that ran the place and take control from the ground up. The amazing thing is that they did it all in nearly total secrecy – operating through back channels, meeting at midnight, scrounging for equipment and skating on the edge of legality. After staging a virtual takeover of one of the world's most elite technical agencies, the Pirate

BY LAURENCE GONZALES

team is now on the eve of the greatest coup in technological history. Having grabbed the electronic guts that run the space program in a hacker heist of legendary proportion, the Pirates are preparing to set foot into space by proxy. Using the next generation of secret technology to create the first new spaceship capable of carrying humans in more than 15 years, they are redesigning the vehicles that boost passengers into space. The Pirates rescued NASA from its past; the question now is whether they can take it into the future.

In 1986, JOHN MURATORE WAS A 29-YEAR-old flight controller working a console in Mission Control when the space shuttle *Challenger* exploded, killing the most famous crew in history. Across the room was Linda Perrine, 21 years old and fresh out of college. After spending six months working on the shuttle's "consumables planning," this was Perrine's first day in the Control Room.

A weird message came down from Cape Canaveral just after liftoff: "Tracking multiple targets." "That was all they said at first," Perrine says. "They were no longer tracking one target but several. Then it was a whole bunch of targets." She looked up at the television screen and saw an orange fireball. A lone dislocated SRB motor took off on its own like a broken bottle rocket, scrawling an angry white trail as it went.

It didn't take a rocket scientist to understand that NASA might cease to exist if changes weren't made fast. Even if manufacturer Morton Thiokol had tried to catch a million tons of flaming rocket fuel with a big condom, NASA's problems weren't limited to the notorious rubber O-ring. The accident was no accident. It was part of a pattern.

For Muratore, the pattern was apparent soon after he set foot inside the Lyndon B. Johnson Space Center, in Houston. NASA was supposed to be the sine qua non of technology. That had been axiomatic through two generations of flight engineers before him. Yet Muratore walked into what looked like the set of a '60s-vintage James Bond movie. Tank-size monitors hanging everywhere around the dismal rooms. No color. No graphics. Only dizzying columns of numbers in those pulsing-green fonts. NASA engineers were still using IBM 3083s, mainframe computers the size of Plymouth Voyagers. Here was Tom Cruise arriving to attend Top Gun School, only to find that everybody drove garbage trucks. It was a nightmare.

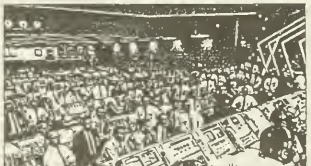
No matter how big they were, the old mainframes could only perform one task at a time; the more tasks, the longer the wait. NASA engineers waited in line as if it were lunchtime rush at a post office with only one window open. Such "centralized computing" had been on its way out for at least 10 years.

And that wasn't the worst of it. When a spaceship flies, those who control it need to know many things at once, from the amount of fuel left on board to the temperature inside a rocket engine. All of this telemetry, as it's known, was beamed down from space in a thundering Niagara Falls of raw numbers. Interpreting them was like being asked to judge the speed of your automobile by leaning out the window and counting how many times your wheels went around. The information was there, to be sure. It just happened to take a superhuman effort to make it useful in real time. Real time is like live television – you see it while it is happening. If your spaceship is going 17,500 miles an hour, it does little good to send the numbers out to be crunched and get the answer back an hour or a week or (in some cases) a month later. You need that information in real time. Like, now. Meanwhile, Muratore realized that as calculations grew more numerous and complex, the time would soon arrive when the titanic IBM 3083 couldn't do the job at all. The iceberg of numbers would rip it open at the seams.

The first crisis came in 1984 – before *Challenger* – during the shuttle mission sent up to repair an important satellite. During launch the IBM mainframe overloaded and locked up, "and we went blind," Muratore says. NASA switched to the backup IBM mainframe, and it overloaded and locked up, too. "We were left sucking air." It was the closest thing they could have to a shuttle explosion without actually losing the ship, and Muratore recalls thinking, "What if [the shuttle crew] needs us now? Now something's going to change."

But nothing did. The bosses didn't seem to notice. The young engineers knew how to write a program for a small desktop computer that could crunch all those numbers in a few seconds and flash a message on the screen or even draw a picture. But no one even wanted to talk about it. The near disaster wasn't publicized, and everything went back to business as usual.

And then it happened again – a major computer failure. It was during simulated re-entry practice after the 1986 shuttle explosion. The computer started sending information to the shuttle orbiter, the part of the craft that glides back to earth, telling it that it was much higher than it actually was. Instead of still being in space, the orbiter was in the atmosphere. As a result of the faulty information about its altitude, the crew sent the aircraft tumbling out of control. In a real flight, the crew would have died. But the managers simply shook their heads. They were so committed to business as usual that as recently as a year and a half ago, they got rid of the old IBM 3083s and replaced them with ES/9000s, an even bigger and more centralized IBM mainframe.



THEN AND NOW: RETRO-NASA'S MAINFRAME TERMINALS (ABOVE); OFF-THE-SHELF DESKTOP COMPUTERS IN THE NEW CONTROL ROOM

IT WAS LIKE TOM CRUISE ARRIVING AT TOP GUN SCHOOL ONLY TO FIND THAT EVERYBODY DROVE GARBAGE TRUCKS.

IN 1963, NASA AND THE AIR FORCE CONsumed 90 percent of the integrated circuits sold in the U.S. They were the only ones who needed such devices. The first personal calculators showed up on the market about the time NASA landed astronauts on the moon six years later. The same companies that had received their start from NASA contracts were now turning those investments into consumer products.

"We grew up with those products," Perrine says. When she arrived at NASA in 1985, "it was clear that the organization that had created that technology was way behind the times." Perrine and Muratore came from the first generation of people who grew up owning computers. To them, computers are what motorcycles were to Marlon Brando's generation: a tool of speed and authority. Consequently, when they first joined NASA in the 1980s, they couldn't believe how primitive the technology was.

Neither could Brian Anderson, a colleague who arrived after the shuttle explosion, when he was 21 and just out of college. Anderson was a big athletic fellow from the Oklahoma plains with black curly hair and a square jaw. In a place where executives at his level wore suits and ties, Anderson wore battered jeans, sneakers and a Bugs Bunny tie. "I came from a small university in an economically depressed area," he says, "and when I saw the Control Center, I was astonished that my small college had better computing."

Challenger was the ritual scarring of this new generation. As the young engineers noticed how archaic the NASA computer system was, discontent began to grow. "I couldn't believe I was taking steps backward in technology," Perrine says. "We're children of the world that NASA made," but NASA managers stayed in the old world. It was a real Peter Pan story.

Thus began a war within NASA between those who wanted big centralized computers and those who wanted to glue a bunch of small computers, or nodes, together to do the job better. The very idea hatched by these so-called Node Pirates was unseemly to the Old Guard at NASA. Aerospace engineers didn't use color. They didn't need any stinking cartoons. They used slide rules. They used math. They ate numbers for breakfast.

Muratore wasn't afraid of numbers. He had risen to the position of flight director of the *Hubble* repair mission. But he knew that to fly spacecraft safely, you need more than raw data; you need easily understood information, and you need it now. When he pressed his case, he was repeatedly met with a little speech: "We put men on the moon. We must be doing something right. Besides, changing a huge system that's being employed to fly human beings into space is simply too risky."

"And blowing up the space shuttle is . . . what?" Muratore would ask himself.

After *Challenger* exploded, NASA went through a

LAURENCE GONZALES *is currently writing a screenplay. His most recent book of essays is "The Hero's Apprentice."*

"reorganization." Hundreds of new people were hired and billions of dollars were spent to make sure it never happened again. At least that's what the public was told. In fact, according to NASA's own engineers, no essential changes in management or philosophy were made. Those who tried became casualties. "There were people who came out of the closet too soon and aren't here anymore," Muratore says. As late as 1989, "one of them was interviewed in *Final Frontier*, in which he was quite frank about what we were trying to do. He named names and in effect flipped the finger at several people." He was shunned and finally decided to leave.

So instead of a frontal assault, Muratore, Perrine and Anderson decided to become outlaws and undertake a campaign of insurgency. There is always a little money floating around in the budget for "new technology." And if you're clever enough to convince someone at headquarters that what you are doing is actually new technology, then you can cadge some of that grant money. So in 1986, Muratore wrote a little grant proposal: This "real-time telemetry model" would be "interfaced with system downlink" using "existing computer technology." Translation: We can do this better with a home computer than you can with your IBM mainframe.

The geekspeak worked. "Of course, you have to have an ally in high places," Muratore says, explaining that there were a couple of people a few rungs up the ladder who winked and supported his proposal. But they were the exceptions. Muratore, Perrine and Anderson were still battling the elective blindness of NASA's middle-level management, and they still feared that any day someone would walk in and say, "You like color graphics so much, why don't you go work for Apple?"

At first the Pirates were given a thin dribble of "research" money. The main piece of hardware they needed to buy was a downlink telemetry processor, one of those engineering terms for a device that funnels information to the computer from the flying spacecraft – if any ships were ever allowed to fly again, that is. After the *Challenger* exploded, spaceflight at NASA seemed to come to a grinding halt. But as depressing as that situation was, it paradoxically gave the Pirates the time they needed to prove their system.

With the precious downlink black box in hand, Anderson and Muratore went around the Johnson Space Center looking for old computer parts. "We borrowed what we could," says Muratore. "We built what we couldn't borrow." Manufacturers of sophisticated electronic equipment were always hanging around NASA like stray dogs at a hunting camp, so Muratore, Anderson and Perrine explained to them what they were trying to do: use small off-the-shelf computers to decode all the information from a spacecraft in flight and present it in real time using a format that anyone could read at a glance. And the manufacturers, who knew desktop computers were the future, tumbled head over heels to provide them with equipment. The problem was that under government regulations, Muratore's group could only use any one computer for a 90-day trial since they could not accept "gifts." So they had to get the computer, program it real fast, make it work and then give it back and do the whole thing all over again. Unexpectedly, this had several tremendously valuable side effects. First, they came to know their own software exceptionally well, having to program it for the quirky personalities of so many different computers. Second, while the old IBM culture might take as long as a year to reprogram the mainframe, they learned to change everything in 90-day cycles. Third, they knew every piece of equipment on the market.

At the same time, the Pirates' work had to give the appearance that they were "flying in formation," as the managers liked to say. Any hint that they were working on a parallel system had to be concealed.

Those were the years of clandestine trial and error, of late-night meetings, of testing this box and that box. The Node Pirates spent their lunch hours and evenings concealed like terrorists, writing code (i.e., computer programming) for their makeshift stealth computer systems. "We had a few younger people in the old system, and they were just as frustrated as we were," Muratore says. "People at other centers would slip us software," Perrine adds.

Gradually some high-level support began to build. For instance, Muratore's boss Gene Kranz, the most famous flight director of all, the one who handled the first lunar landing, quietly told them he'd give them a hand.

Finally, one day in April 1988, Muratore, Perrine and Anderson came into the Control Room and found an empty spot on one of the long benches and set their computer up. But the managers wouldn't let them plug it in. It seemed they had come all this way only to have the managers balk at connecting the single wire that would make the whole thing go.

But then Kranz, shuttle program director Dick Truly and a couple of other old-liners who supported them came out and said, "Why don't you give these kids a chance?"

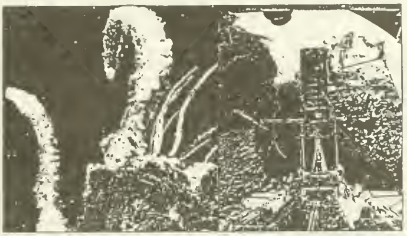
The middle managers of Mission Control grudgingly hooked it up. It was a curious moment. No one wanted to seem disloyal to the old system, but even the most myopic controller could hardly ignore the new dingus. It had a color screen. It gave information in English. It even drew such pictures as a schematic diagram of the dreaded communications system, which had more loops than an Irish sweater.

Arthur C. Clarke wrote, "Any sufficiently sophisticated technology is indistinguishable from magic." And to the flight controllers, the box that the Node Pirates (their ranks now swollen to about eight) put in the control room looked like magic. It did what no one before had been able to do. That knocked-together computer system sat there processing the shit storm of numbers from simulated space missions and transforming it into simple statements: "TV camera overheated" or "Command receiver failed."

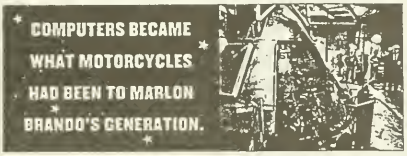
Now the controllers started to swivel around in their seats to see what the gadget was saying. At first they would only turn around from time to time to check the new computer against their stuff. Soon a controller sweating bullets to figure out what his screen full of swamp-green numbers might mean would swivel around and get the answer instantly from the color screen.

And then one day during simulation, the mainframe crashed, but the booster controller kept calling out information. "Where the hell are you getting this data?" asked the flight director, looking at his own frozen screen. "I'm getting it off the work station, Flight," the booster controller answered. Suddenly, everyone was looking at the Pirates' node. The mission had been saved with a tinkertoy dingus.

After that, the controllers found themselves facing all the way around, turning their backs completely on their consoles. Anderson, Perrine and Muratore had literally and figuratively turned the control room around. A lot of people were really pissed.



A ROGUES' GALLERY: "CHALLENGER" EXPLODES; "HUBBLE" TELESCOPE GETS EYE SURGERY; THE APOLLO CAPSULE IN WHICH THREE ASTRONAUTS DIED (CLOCKWISE FROM TOP LEFT).



UNTIL THAT TIME, THE magic of formatting data had been the sole domain of the big-system developers – the technical managers. Muratore had started out as one of Gene Kranz's console jocks, a pilot who didn't leave the ground during flight. When this whole computer war began, Muratore had returned to school at night to get his master's degree in computers. Thus console-jock-goes-techno-dweeb didn't sit well with the Old Guard. The secret of the magic was getting out. Flight controllers were expected to use what was given to them, but Muratore and his team had crossed a sacred boundary and had put magic into the hands of controllers. Now the flight controllers had the power to know exactly what was going on while it was going on. They could change the system. They didn't need developers. They were talking to outer space! They could tell if an astronaut took a pee. (Well, a simulated pee, anyway.)

Then NASA decided it was time again for the real thing. The shuttle mission STS-26 was scheduled for a September 1988 liftoff. In the spring, Steve Bales, the head of systems division in Mission Control, had a crew down in Mississippi testing engines when he realized with a cold jolt that the rocket motors could develop a glitch that would result in the "loss of the vehicle," as the engineers, in a triumph of euphemistic delicacy, put it. That was bad enough; a glitch can be fixed. The larger problem was that the trusty old mainframe at Mission Control was unable to detect it. So if the deadly glitch were to occur, the old mainframe would happily spew numbers while the newest space shuttle fell into the sea.

In May 1988, Bales called Muratore and told him the problem. "Uh, we have this set of, um, you know, failures we've detected in the test stands," Bales said, "which could

h- -n in flight, and all of our conventional tools in the l- -nanframe can't detect them. We're talking loss-of-vehicle scenarios here, John. Can you do this and be ready to fly on the first flight?"

"My heart was pumping a mile a minute, and my stomach was upset," Muratore recalls. "This was the defining moment of the whole effort. Up to that point, no one was going to die if our system didn't work. And this was the first flight after the accident."

Muratore and his team went to the institutional computer and software developers and met with them all day until 7 p.m., trying to convince them of the importance of creating this new system. But the managers wouldn't work with them; they didn't care what some guys testing engines out in a Mississippi swamp had to say. So Muratore and his team went off on their own – without approval and without assistance – and they did the job anyway.

"This was an intense time," Muratore says. "We had one shot at this, and then it was going to be the end of everything. We either did it or the whole organization went under with another accident." Less than three months later Muratore's team had the system ready.

The gizmo the team wound up with was a modern computer workstation with color graphics. It consisted of four or five console positions into a single display. There were clear, precise fault messages to signal if something went wrong. And it had a built-in interface like a VCR control panel so that the flight controller could rewind for instant replays of anything that looked interesting – an up-to-the-second feature in Mission Control. But was truly magic.

NASA administrator Jim Fletcher and Dick Truly both came down to Houston to look at the system a few weeks before the flight. "Looks like you guys know what you're doing," Fletcher said. Then Fletcher went back to Washington, leaving them to the wolves. If the managers had been pissed before, now they were really enraged. There was one guy," Muratore says, "he couldn't even speak to me; he just got beet red every time I talked past." One of the things he hated most was the fact that Muratore carried a disk in his shirt pocket that contained the whole code for telemetry – from launch to landing of the space shuttle – while the old system practically had to have its own building. "You're not flying in formation with us," Muratore was warned.

Still, Muratore was given leeway for that first flight after the *Challenger* explosion. A few minutes before T minus 0, there was a mad rush to void bladders, and Muratore found himself standing at the urinal next to Gene Kranz. There he was, the young upstart who had defied Kranz's righteous flight-control system. Kranz glanced over at Muratore, smiling perhaps with pride and a little nostalgia for this delicate moment of male bonding. "OK, John," he growled. "This is it. Are you ready to process data from a real vehicle in flight?" Muratore nodded. Mr. Mission Control zipped up and walked out.

The bird went up, and the tower fell away, and a cloud of steam rose into the dawn. It was the end of the death knell of the IBM mainframes and the signal that the old generation of NASA managers from the Apollo days was on its way out. "We had out computer system running in August 1988," Muratore says, "and it's run on every mission ever since."

Now the covert war was out in the open. Muratore's embryonic group, which had once been busy snatching computer parts, was now envisioning a whole new design for Mission Control. But despite the group's success with the shuttle liftoff, it hadn't won the war with that single shot.

While trying to figure out a strategy, Muratore had read about a theory of corporate evolution: Barbarians invent a new culture, then managers come along to keep it going, and finally aristocrats spring up out of the manager class to perpetuate a comfortable way of life for themselves, at which point new barbarians must come in and smash everything to bits and start over. "We need barbarians now," he said.

MUTINY ON THE BOUNTY: NASA'S PIRATES PERRINE, ANDERSON AND MURATORE (FROM LEFT)

"WHEN I SAW THE CONTROL ROOM, I WAS ASTONISHED THAT MY SMALL COLLEGE HAD BETTER COMPUTING."

Particularly since NASA's history seemed to fit the model. At the time of the moonwalk, the average age in flight operations was 26. Flight ops was the single most heady culture in America at that moment in history. "We were on an absolute high," says Glynn Lunney, one of the most famous flight directors. "The people who came in new out of school, they didn't know they shouldn't do things or couldn't do things." Those people wouldn't have traded places with the Beatles.

It was the youth culture of the '60s with a Ph.D. It was nonpolitical, nonbureaucratic and as urgently imaginative as anything spawned in Haight-Ashbury. But it now seems that NASA began its decline the moment Neil Armstrong set foot on the moon. The agency went from being a sleek organization of brilliant innovation to a big old traditional bureaucracy with glacial inertia. Success brought along with it professional administrators and civil-service regulations that ended the free hand in hiring. By the 1980s, when Muratore, Perrine and Anderson came in, the budget was $7.7 billion, the work force 22,000, and the administrators at NASA headquarters amounted to one-third of the work force.

The change from a technical to a bureaucratic culture led directly to a series of disasters: In 1979, earthlings wondered who would be hit by pieces of the *Skylab* space station; in 1986, *Challenger* blew up; in 1989 the Jupiter probe *Galileo* was beset by troubles; in 1990 the *Hubble* space telescope's built-in flaws revealed themselves us billions of dollars worth of disappointing photos; in 1993 the *Mars Observer* vanished, taking decades of scientific research with it. How many counterfeit miracles were we expected to endure? And at what cost? Even corruption had begun to taint the agency. Authorities were conducting hundreds of criminal investigations concerning bribery and kickback schemes and billions of dollars that were unaccounted for.

But if the managers and aristocrats were to blame, so were the old barbarians, the Apollo veterans. They were still referring to what Muratore, Perrine and Anderson had done as fairy dust.

"Some of those people had worked in those same systems for 30 years," Muratore says. "How do I walk in and tell them, 'Nope. You guys are full of it'?"

When TRW vice president Dan Goldin was appointed by George Bush to head NASA in 1992, Muratore's group had already been at work on its parallel system for more than four years – with only occasional success. Goldin was across the country in Washington and had never even heard of John Muratore. He was too busy trying to save the agency. Just a year after his appointment, the House came within one vote of altogether eliminating NASA's space-station budget. After Bush and Dan Quayle – Goldin's patron – were turned out of office, Goldin was kept on. Some said he was a chameleon who could change colors to save his job, but even his enemies have nothing but praise for his abilities. A big athletic man who wears shirt sleeves, cowboy boots and a Skypager, Goldin used to ride 100-mile bike races and run 35 miles in a weekend. Three years ago he arranged with the Academy of Motion Picture Arts and Sciences to fly the Oscar on the space shuttle. Goldin has style. Insiders at NASA call him one of the smartest people they've ever met.

Although Goldin was spending most of his time in Washington, he was making bureaucratic changes in the way things were being done back in Houston. The first and perhaps most radical was to gore the sacred ox Apollo. Goldin began by announcing to everyone at NASA, "Don't give me any of that crap about how you did it in the Apollo days." People were shocked. "It amounted to heresy," Muratore says. "The second thing he did was to use money to force us to change the way we did business. His cost-cutting goals forced us to respond." Third, Goldin insisted on measuring the results. "He wants to measure everything," Muratore says. "How many people does it take? How many lines of code are there? How many racks of equipment?" With those three changes, Goldin sent out a new message, Muratore says: "Taking risks was OK again."

Very soon the changes in NASA culture that Goldin instituted trickled down to benefit Muratore. That manager who used to turn beet red when Muratore walked by? Muratore eventually got his job. Now instead of his unofficial leadership of a few merry pirates, Muratore was formally in charge of 1,400 contractors and civil servants who lay in confusion at the feet of the newest NASA idol, the projected $12.7 billion *Freedom* space station, which has since been renamed *International Space Station*. Muratore was told to redesign the sacred control center. The project had so far been a Tower of Babel. Muratore was supposed to straighten it all out and not spend too much money. "You like fairy dust?" a skeptical hard-liner asked him. "Good. Put some fairy dust on *this*."

Muratore began by outmaneuvering those he couldn't convert and co-opting those he could. First, he says, he told the Apollo hard-liners: "You're all pirates. Make believe that your country was taken over, and you're forced now to be a pirate. You don't have money, you just have your ships and your skills." In one sense, Muratore was right. Soon after the 1988 shuttle flight, NASA funding was drastically cut. There would no longer be elephant bucks for custom IBM mainframes. In fact, word from Washington was

that if NASA couldn't do it on the cheap and off-the-shelf, then NASA couldn't do it at all.

"Pirates don't have time for filling out paperwork," Muratore told the old boys. "Does it put food on the table? No. Do we go and attack impossible objectives? No. We attack targets where we know we can win."

Anderson and Perrine were Muratore's first mates. He also developed the Pirate Code. The first rule is "Pirates have to know what they're doing." One of the problems that had developed inside NASA before the *Challenger* explosion was that it had become possible to be in a position of great power without really knowing the vehicle intimately.

There's a story about the shuttle orbiter. When it's lying on the ground in a horizontal position, it has a steel plank inside it, for use as a work platform. Before the orbiter is pointed skyward for launch, that bright-yellow beam must be removed. NASA had a procedure to ensure that it was done; in fact, 18 people had to sign off. Well, one day they lifted the thing up, and *whump!* The beam fell out. Who the hell left this thing in there?

Nobody. Nobody was responsible because everyone had signed the piece of paper. Today there is only one person, one signature. The second rule of the Pirate Code is "If we fail, there is no mercy."

I STOOD WITH MURATORE, PERRINE AND ANDERSON, watching the space shuttle migrate around the globe on an immense 3-D color display at the front of the new control room, which is housed in the new wing, an addition to Building 30. The room, which smelled like a new automobile, was the size of a suburban movie theater, done in deep, gentle blue and gray tones that hinted at the sky just before nightfall – or just at the edge of space.

"The old model," Anderson said, comparing it with the 3-D space shuttle we were watching, "was like a plastic shuttle over a flat earth. You couldn't tell what attitude it was in, and you had to have pages and pages of numbers just in order to calculate how to turn the thing around. Marv LeBlanc [chief engineer of the Control Center] developed this whole thing underground on his own with Silicon Graphics. It's becoming the standard all over the world." It's the equivalent of a fighter-plane program on your Macintosh.

At one point, a new, separate control room – conceived but never built – had been intended to control the *Freedom* space station. Shuttle operations were to have continued in the old control room: separate crews, separate computers, separate systems. In fact, until the Node Pirates blew the walls down, the two buildings weren't even properly connected. The floors weren't even the same height above the ground. But the Pirates said to put in new Digital Equipment Corporation desktop computers, and you could change the shuttle control room into the space station control room just by switching software. Now there is a single control room, a single building (connected to the old building by little half-flight staircases to make the floors match up).

Dozens of computer monitors glowed with colorful X Windows displays. A beige serial mouse lay ready on a DEC mouse pad at each station. It was a triumph not only for the Pirates but for DEC, IBM's archenemy.

"I call it the Mrs. Baird's Bread Computer," said Anderson, who wrote the specs for it, "because that company uses the same software. It's just an off-the-shelf computer." Anderson, with nothing more than a bachelor's degree in physics from a little-known technical college, has risen to become one of Muratore's office chiefs. Because of the intense period of 90-day free trials, Anderson was able to write specs for this contract that made every computer vendor in the country sit up and beg. When DEC finally came in with the low bid, the Pirates had one of the best deals in NASA history. Each console, including computer, three monitors, keyboards, mouses and interfaces, costs about $25,000, a savings of $15,000 to $20,000 over the price anyone else would have paid for the same system. NASA bought 200 of them.

The UNIX X Windows software was designed by 20-year-olds at MIT. If one of the ES/9000 computers broke, a team of board-level technicians had to be standing by to fix it. With the DEC Alpha, anyone could slide out the broken machine and slide in a new one. "Six screws, four connectors," Anderson said. "You keep a spare on the shelf." Send it back, and DEC gives you a new one the next day.

With Goldin's backing, Muratore and his group have moved to institutionalize the subversive, the revolutionary underground element. Everyone wears a Pirate team button now, showing a skull and crossbones wearing a headset. "The real challenge now," Muratore said, "is not to become the enemy."

We went up to the old control room to see it one last time. The monochromatic computer screens at each position displayed the antiquated cascade of numbers. Paper and books and manuals were stacked everywhere. Laptop computers had sprung up at every controller's position to do the work that the mainframe couldn't handle. It was almost sad now that the mainframe had been defeated – like a big old beast turned out to pasture after a long life of toil.

The Node Pirates' schedule and budget, set in January 1994, remained on track, and they received Vice President Gore's Hammer award for reinventing government, a $5 hardware-store hammer with a ribbon around it. They now operate with fewer people at less cost: 680 operations staffers, down from 780 last year, with plans for a 450-person staff in two years.

GLORY DAYS: BUZZ ALDRIN DOES THE MOONWALK.

THE MISSION WAS SAVED WITH AN OFF-THE-SHELF TINKERTOY DINGUS. AND A LOT OF PEOPLE WERE PISSED.

NOW THE NODE PIRATES ARE MOVING INTO the future. Muratore has just been given the go-ahead to prove he can develop a new type of spacecraft to carry human beings using off-the-shelf technology for one-tenth the cost of any that has previously been proposed. His new X-35 development group is going to try out the Pirate approach. He has till October to show some results. "The technology is out there," Muratore says. "It simply has never been integrated."

This groundbreaking project came as a surprise. A few weeks ago, Goldin called Muratore and said, "Be at the airport at 8 a.m. I'll meet you on the private jet. Be ready to brief me on the aircraft thing." Goldin scarcely said hello when Muratore boarded the NASA plane. Goldin simply said, "Start the briefing." Muratore had a video recorder and a tape to show him.

Goldin then said, "We're not going to cut you kids off at the knees. We're going to give you a chance." Then he threw Muratore off the plane in Washington and said, "Find your own way home." "I didn't even know what city I was in," Muratore says.

The craft is called a lifting body, a deltoid vehicle with a shape like a giant pumpkin seed that uses its whole body – not a set of wings – to produce lift. Muratore sees this as happening in several steps. The first step would be to have an emergency escape pod attached to the space station. The occupants could jump in and glide down to earth in the event of a fire or an emergency. The second phase would be to use conventional rockets, such as the expendable launchers that now put up satellites, to launch the X-35 back up to the space station. The third stage would be to carry the X-35 aloft, slung underneath a 747, then drop it. It would then fire its own jets and rockets and lift itself into orbit using secret "scramjet" technology. Scramjet, tested in primitive form on the SR-71 Blackbird spy plane, is an exotic technology that only works during hypersonic flight – at speeds many times faster than that of sound. This approach represents the first true revolution in spaceflight since World War II. Since the days of the first space capsule, we've had essentially the same approach to getting into orbit: the human cannonball blasting off from the ground. Coupling the X-35's lifting body with scramjet would not only wildly reduce the cost of spaceflight but take the game to the next level.

The politicians who control NASA's funding at least pay lip service to such thinking. House Speaker Newt Gingrich, for instance, who earlier this year commented to one of his classes that NASA should have been eliminated after the Apollo missions in the 1970s, now says that it should continue to reinvent itself and develop new technology that can spin off into American industry.

Yet once again the Pirate approach is running into obstacles. "There was a large community that said, 'We need a capsule for an escape pod,' " says Muratore. "But, that's old technology. It has nowhere to go. It's a dead end. We picked a solution that has future possibilities."

And so begins a new Pirate war. Despite Goldin's encouragement and support, Muratore and his team are going back into the trenches to battle it out, probably for at least several years. This time they're not just attacking somebody's computer. They're going after the original Right Stuff, the aircraft design.

"They're attacking from all sides," Muratore confides to me in a tense whisper. "They're trying to grab our funding. This is going to get ugly, and we can't turn to Goldin to bail us out this time."

What are you going to do? I ask.

"I'm putting the knife in my teeth and climbing the mast," Muratore respoods. ■

The CHAIRMAN. With that, let me turn to Mr. Hall for any questions that you might have.

Mr. HALL. Thank you, Mr. Chairman.

I'll start off, I guess, with Ms. Lee. While she was not a part of the Hubble MIR flaw, the hiatus that we got into there, perhaps you're part of the solution to it.

The committee, as you know, in past years spent a lot of time examining NASA procurement after the discovery of that flaw—how did it happen and why. We even had some hearings on what the reaction was and the amounts of civil settlement and the machinations that went into the Justice Department's decision to accept a settlement that looked way short to some of us who probably didn't have the information that they were operating under, that they had to use to work their settlement.

But, for the record, you probably instituted some initiatives to try to see that something like that does not happen again. I'd like for you to discuss whatever procurement reforms that have been set up and whether or not you need enabling legislation or if you think you have sufficient authority under the existing program. Are you the one for me to ask that?

Ms. LEE. Yes, sir. I can give you a brief summary of where I think we're going on that. And again, getting back to a change, John and I spent a great deal of time talking about this—a change—and I think some of the other gentlemen referred to it.

Culturally—I hate to use that tried and true word but the change of NASA's approach and NASA's thinking of instead of dictating how we do something, giving industry the opportunity to say, "This is the result we desire, you figure out the process to get there."

Under the Hubble—albeit there were a lot of other contributing problems—I think one of them was certainly the fact that NASA specifically wanted to direct the "how", not the "what" and our involvement in the everyday interaction in those changes. Different from the approach that John took with the change in mission ops and different from the approach that a lot of our industry counterparts are recommending.

We, at NASA, have recognized that we really in those cases where we expect industry to step up and accomplish our desired result, we have to clearly articulate that, come to a mutual agreement—whether it be a contract, cooperative agreement, whatever the appropriate agreement between the parties is—and manage that accordingly, then step back and accept the results.

We also have to balance that with the fact that I think we all recognize space is high risk and there will be some issues and there will be some problems and we have to learn to balance and accept the difference between those.

Mr. HALL. It's still a fragile mission.

Ms. LEE. Yes, sir.

Mr. HALL. Mr. Chairman, if I run over a little I assure you I won't ask for a retake in just a moment. But I want to tie in what I'm asking. I want to tie in and get some other answers because Mr. Dunn, from ARPA, discussed the use of the space authorities to enter into "other transactions" in carrying out the mission. I

guess I'd like to know under what circumstances does NASA make use of that other transactions authority?

Mr. DUNN. Well, I'm not sure I should be answering for NASA but as a historian by avocation I can give you some background on that.

Mr. HALL. I'm going to ask Ms. Lee to comment after you.

Mr. DUNN. Okay.

The example that I gave of Telstar I, the launch service agreement that allowed that satellite to be launched, was a Space Act agreement. The other examples that I mentioned, the Delta upgrade agreement, the joint endeavor agreements, were examples of the Space Act agreements authority.

Another example was last year we had a number of programs that were being run jointly between ARPA, NASA and several other government agencies to encourage development of technologies. And in many of those instances we sent, ARPA sent DOD funding to NASA to execute those agreements. NASA's instrument of choice to execute those agreements was a cooperative agreement.

In certain instances—at least one instance that I'm aware of, they ran into an impasse and could not reach final agreement on the cooperative agreement with commercial firms over intellectual property issues. And in that instance they pulled the agreement up to NASA headquarters and negotiated what I would call an "other transaction," a Space Act agreement. So that was an example of NASA using that authority on an exceptional basis rather than integrating it into their contracting technique as a routine way of doing business.

Mr. HALL. We've got an old saying: "Be not the first by whom the new is tried" and yet we're the last to lay the old aside. But the word "other transactions" kind of opens the gate and you're a lawyer and I can take you on, because I'm a lawyer. Lawyers can cuss lawyers but we don't like anybody else to get on our case.

But lawyers are prone to mention only the cases they won, not the ones they lost. You mentioned Delta and Telstar. There are other circumstances where you got off into that vast area of "other transactions" that have not paid off and can you envision some?

Mr. DUNN. I don't have any examples of them. Of the 100-plus agreements that we've entered into in ARPA they're all working very well. In fact, I have here a copy of a participant survey that the Institute for Defense Analysis did on our other transactions where they've contacted dozens of participants. This is a draft. I expect to have the final version within a week and I would request the committee's permission to hold the record open and I will provide you a copy of the reaction of folks who have worked with us in these other transactions.

The CHAIRMAN. Without objection.

[The survey referred to follows:]

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DRAFT

Participant Views of ARPA "Other Transactions"

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November 27, 1995

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PREFACE

This report presents the results of a survey of organizations that have participated in research projects conducted under the "Other Transaction" authority of the Advanced Research Projects Agency (ARPA). ARPA's General Counsel plans to prepare a report on ARPA's use of this special contracting authority and wishes to include the views of companies who have participated in these arrangements as to what the benefits have been. The work was performed under an ARPA-funded task entitled "Benefits Review of 'Other Transactions' Authority."

The authors wish to extend their warmest appreciation to Dr. Harlow Freitag (formerly of IDA) for his invaluable assistance and to thank the reviewers of this paper, Mr. Herbert R. Brown, Dr. Marvin H. Hammond, Mr. Terry Mayfield, Dr. Robert M. Rolfe, and Dr. Richard H. White, for their help in improving its content and organization.

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EXECUTIVE SUMMARY

The Institute for Defense Analyses (IDA) was tasked by the Director and General Counsel of the Advanced Research Projects Agency (ARPA) to survey organizations that have participated in special contractual arrangements called "Other Transactions." Other Transactions are used between ARPA and its private sector research and development (R&D) partners, and have been characterized by their enhanced flexibility and reduced administrative burden when compared with the typical Government procurement contract.

IDA used an interdisciplinary team with experience in computer science, manufacturing practices, Defense research, public administration, and acquisition law and regulations. Letters describing the survey efforts and a set of discussion questions were provided to the participants in advance so they could prepare for the interviews, most of which were conducted by telephone. The results of the survey are largely anecdotal; the reported results were not quantified to avoid implying either numerical precision or statistical significance that was not in keeping the survey's size or methods used. The questions and results centered on the following areas.

Effectiveness of Programs Conducted Under ARPA Other Transactions. In general, participants viewed "effectiveness" to mean increased flexibility, increased efficiency, and enabling new technologies and programs, all of which Other Transactions met in some way. Other Transactions were said to allow R&D to go forward with a minimum of bureaucratic encumbrance.

Program Administration. Participants reported that Other Transactions reduced contractor administrative overhead, simplified work reporting to ARPA, and increased researcher productivity.

Partnerships, Consortia, and Teamwork. Consortia formed under the Other Transactions have created new projects, relationships, and other business ventures as a result of the working relationships and rapport established through the Other Transactions. But forming a consortium often proved to be difficult and time consuming. Clearly establishing the roles and responsibilities of all players as early as possible and choosing

an appropriate consortium leader were critical to the success of the venture. The most likely areas of disagreement in consortia related to trade secrets or other intellectual property issues and it was often helpful to have ARPA or a Government laboratory as a non-voting member of a consortium to act as a neutral referee in inter-company clashes.

Mechanisms for Reviewing Progress and Making Payments. Researchers were pleased with the ability to establish milestones up front and to base progress payments on attaining milestone objectives instead of reporting cost as a payment metric with a set of fixed deliverables. The one area for criticism was payment promptness. Some participants suffered from extremely slow payments, while others reported unusually prompt payment.

Foreign Access to Technology. Some participants reported problems related to participation in their consortia by foreign-owned firms. ARPA requires a consortium to notify ARPA of proposed foreign access and to obtain prior consent. This provision generally allowed sufficient flexibility for the respondents to deal with changes in their plans for foreign access.

Intellectual Property Rights. In general, respondents reported either that the patent rights regime imposed under the Bayh-Dole Act posed no difficulty for them, or that ARPA showed sufficient flexibility to develop a different allocation of rights that was acceptable to all parties.

Potential for Fraud, Waste, and Abuse. Respondents generally saw no greater risk of fraud, waste, or abuse under an Other Transaction than under a standard procurement contract. Many said that the members of a consortium have the ability to monitor one another and, as a result, to minimize the risk for these types of problems. In addition, the general requirement that research under an Other Transaction be done on a cost shared basis was recognized as a great inhibitor to waste.

Cost Sharing. Cost sharing proved to be a true test of a company's commitment and weeded out some consortium members with marginal commitments. However, some respondents suggested that ARPA should be willing to vary the participants' required share of costs when circumstances, such as the involvement of small companies or greater risk of the project, warranted.

1. INTRODUCTION

The Defense Department's Advanced Research Project Agency (ARPA) has had "Agreements Authority"—the authority to enter into contractual arrangements called "Other Transactions" with its private sector research and development (R&D) partners—since 1989. Other Transaction agreements are characterized by enhanced flexibility and reduced administrative burden when compared with the typical Government procurement contract. Congress granted ARPA this authority in recognition that a procurement contract is not the appropriate type of agreement for every form of Government-supported science and technology project, a principle recognized in the Federal Acquisition Regulation (FAR) itself.[1] Grants and cooperative agreements are generally appropriate to support and stimulate public purposes like the advancement of science and technology. However, Congress has recognized that even the use of standard grants and cooperative agreements cannot provide sufficient flexibility for the needs of every appropriate ARPA research venture. ARPA's use of Other Transactions has frequently been misunderstood ever since it was originally enacted. For example, press reports often mistakenly refer to Other Transactions as "grants."

ARPA's Director and General Counsel requested the Institute for Defense Analyses (IDA) to contact organizations that have participated in Other Transactions to elicit those organizations' views of the benefits and drawbacks of the Other Transaction so as to have an independent assessment of the value of Other Transactions *vis-à-vis* other types of funding arrangements, and to make recommendations to improve the process. IDA researchers sought to elicit those participants' views in nine specific areas:

1. Effectiveness of programs conducted under ARPA Other Transactions
2. Program administration

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[1] FAR § 35.003(a) reads: "Contracts shall be used only when the principal purpose is the acquisition of supplies or services for the direct benefit of the Federal Government. Grants or cooperative agreements should be used when the principal purpose is to stimulate or support research and development for another public purpose."

3. Partnerships, consortia, and teamwork
4. Mechanisms for reviewing progress and making payments
5. Foreign access to technology
6. Intellectual property rights
7. Potential for fraud, waste, and abuse
8. Cost sharing
9. Suggestions for improvements in the use of Other Transactions.

IDA used an interdisciplinary team with experience in computer science, manufacturing practices, Defense research, public administration, and acquisition law and regulations. This team was also informed by IDA's involvement with the use of Other Transactions by ARPA in the context of the Technology Reinvestment Project (TRP) beginning in October 1992.[2]

This document presents the results of IDA's survey.

In fiscal years 1990 through 1993, ARPA entered into 19 Other Transactions having a total award value of $194 million. These 19 agreements represent 4% of the 471 ARPA projects initiated during that time period and this $194 million represents 11% of the $1.82 billion total award value of those 471 projects. For fiscal year 1994 and the first three quarters of fiscal year 1995, the comparable figures are 70 Other Transactions out of 174 projects (40%) and $972.2 million out of $1.276 billion (76%). These latter figures include many projects funded under the Technology Reinvestment Project.

ARPA's authority to enter into Other Transactions in support of basic, advanced, and applied research projects that are not feasible or appropriate for standard contracts, grants, or cooperative agreements is granted by a statute, 10 U.S.C. § 2371. ARPA is not required to include the customary FAR and Defense FAR Supplement (DFARS) clauses in Other Transactions, but is free to negotiate provisions that make sense for the particular project being supported by each Agreement and that are mutually agreeable to both the Government and the performer or consortium of performers.

Under 10 U.S.C. § 2371, Other Transaction authority may be used:

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[2] The TRP represents the widest use of ARPA's Agreements Authority thus far. The limited use of such authority by other agencies acting on ARPA's behalf in negotiating TRP agreements was a large part of the impetus for this study, which examines the use of Other Transactions by ARPA prior to the TRP experience from the point of view of the researchers who participated in them.

- whenever the use of a standard contract, grant, or cooperative agreement is not feasible or appropriate;
- for transactions whose principal purpose is to stimulate or support research and development for an authorized purpose, subject to the limitation that it may not be used to sponsor basic research at a single university or non-profit research corporation (since standard grants were used for that purpose when Other Transactions were first made available in 1989); and
- in situations that are clearly neither "procurement" nor "assistance," as those terms are customarily used to categorize Government contracts (for example, advancing the state of the art in some field, demonstrating technology, developing standards, transferring technology, encouraging collaboration, and fostering exchanges of information do not fall into either category).

The authority may not be used:

- in situations where the principal purpose of the transaction is to acquire goods and services for the direct benefit or use of the acquiring agency, although some incidental acquisition of property or services is impliedly acceptable; or
- for research that duplicates work under any existing Department of Defense (DoD) programs.

The statute also requires that the amount of Government funds provided under an Other Transaction must be matched by an equal amount of funds from the other participants in all instances in which such cost sharing is practicable.

Authorized or public purposes for which Other Transactions may be used are determined by DoD's mission as specified in its organic statutes, authorizing and appropriations legislation; by other legislation such as the Technology Transfer Act; or by pertinent Presidential directives and Government-wide regulations.

Examples of some of the types of Other Transactions ARPA may enter into include:

1. Bailments involving the lending or borrowing of equipment, typically with a sharing of research or test results.
2. Parallel or coordinated research involving ARPA sponsorship of a research project that is related to one or more research projects funded by others and involving an arrangement to share results or to coordinate the research so as to enhance the end result of each project.

3. Consortium agreements with multiple parties, when those parties have agreed to join together to perform research as a consortium. The consortium need not be a legal entity with the power to contract. A contractor, grantee, or sub-contractor relationship may not be appropriate.

4. Joint funding arrangements with others to finance a third party to conduct research.

5. Reimbursable arrangements that involve ARPA providing services (such as transportation services on an experimental space launch vehicle, or experimental air or undersea vehicle). The recipient would typically provide one or more of its own experiments to be conducted during a test mission. The amount of reimbursement to ARPA could be fixed, depending on the extent to which the user's experimental data is to be shared with ARPA and the extent to which it supports an ARPA program.

Since being given its Agreements Authority, ARPA has entered into nearly 100 Other Transactions. Most of these have involved partnerships or consortia, either already existing or formed specifically to conduct a particular ARPA-sponsored research or development effort. As a consequence, much of the response to IDA's survey addressed the formation and operation of consortia. Projects included in the survey include the Display Materials Consortium, Investment Casting Cooperative Arrangement, and Integrated High-Performance Turbine Engine Technology (IHPTET) Fiber Development Consortium.

2. METHODOLOGY

Using contacts identified by ARPA Program Managers who had worked with participants in Other Transactions signed in fiscal years 1990-1993, IDA conducted interviews with as many participants as possible. The projects and organizations included in the survey are listed in Appendix A. IDA used an interdisciplinary team consisting of researchers with experience in computer science, manufacturing practices, Defense research, public administration, and acquisition law and regulations. Letters describing the survey effort and a set of discussion questions were provided to the participants in advance so they could prepare for the interview. These letters and questions are reproduced in Appendices B, C, and D. In some cases it proved impossible to make a connection in a timely way, so some participants and some projects are not represented in the survey results (see Appendix A).

Most interviews were conducted by telephone; some were conducted face to face. When it seemed appropriate, IDA researchers contacted a participant a second time for follow-up or clarification. The results of the interviews were then collected and interpreted and prepared for presentation as a set of briefing slides and this report.

This survey results are largely anecdotal. We have avoided quantifying the reported results so as not to imply either numerical precision or statistical significance that is not in keeping with the survey's size or the methods we used. However, we believe that the participants we contacted are typical of the body of ARPA-funded researchers and organizations and that they—and their responses—are representative of those who have been involved in Other Transactions.

3. STRUCTURE AND CONTENTS OF AN OTHER TRANSACTION AGREEMENT

The typical ARPA Other Transaction agreement is much simpler and shorter than a procurement contract. While there is no one format for such agreements (because they can be used for such a wide variety of differing transactions), ARPA does have a "Model Consortium Agreement" that is fairly typical. This model consists of a cover sheet, thirteen articles (most of them quite brief), and five attachments.

Articles

1. Scope of the Agreement
2. Term
3. Management of the Project
4. Agreement Administration
5. Obligation and Payment
6. Disputes
7. Patent Rights
8. Data Rights
9. Foreign Access to Technology
10. Officials not to Benefit
11. Civil Rights Act
12. Order of Precedence
13. Execution

Attachments

1. Statement of Work
2. Report Requirements
3. Schedule of Payments and Payable Milestones
4. Funding Schedule
5. List of Government and Consortium Representatives

Article I, "Scope of the Agreement," typically contains a vision statement for the project that is worked out jointly by the consortium and Government representatives. This vision statement is critical in giving the parties a clear joint understanding of what they are undertaking from the very beginning.

4. PARTICIPANT RESPONSES

This chapter sets out the responses of survey participants to the discussion questions posed by the IDA investigators. The initial set of these questions—three were added later in the course of the interview process—is included in Appendix D. *The reported opinions in this section are those of the various participants, not of IDA or any individual member of the IDA study team.* No attribution is given for particular statements because the participants were promised anonymity in exchange for their open and candid participation.

4.1 EFFECTIVENESS OF PROGRAMS CONDUCTED UNDER ARPA "OTHER TRANSACTIONS"

IDA asked participants to consider their experience under the Other Transaction in comparison to other Government contracts (if the organization had any) or similar commercial arrangements. In particular, we asked them to consider:

1. the reasons why the Other Transaction worked or did not work for their organization;
2. their interactions with ARPA—or with another agency acting as an "ARPA Agent" for the Other Transaction; and
3. both strong points and problems encountered using the Other Transaction agreement in terms of business issues (the agreement itself and its administration), managerial issues (the consortium and research project and their administration), and technical issues (the performance of the technical tasks under the Other Transaction).

Participants were generally very enthusiastic when asked about the effectiveness of programs conducted under Other Transactions. Effectiveness in this context tended to mean:

- the program would not have occurred, and the work would not have been undertaken, without the use of the Other Transaction;
- it would not have produced equally meaningful and useful results; or

- it was more efficient or less expensive than it would otherwise have been.

The remainder of this section presents some of the specific issues respondents discussed regarding effectiveness.

4.1.1 Flexibility is a Key Aspect of Effectiveness

Flexibility was cited most by participants as the key element of Other Transaction effectiveness. Management by a steering committee with ARPA consent and oversight allowed necessary and appropriate changes of scope and technical direction to be made easily and fostered free and open sharing. Participants were able to easily restructure the research when a change of course was necessary, making mid-course corrections under the guidance and oversight of the ARPA Program Manager as they learned from research results. The flexibility of ARPA Program Managers and contracting officers made changing the schedule in response to changing research needs easy.

The power of a consortium is in its steering committee, which can run the consortium like a commercial program, making changes as needed. This power means less administration and more flexibility for the consortium members. One participant described the Other Transaction as "an order of magnitude" more effective at allowing this kind of agility than a procurement contract. One consortium found that for technical reasons, it had to completely redo its program early on. All the members had to do, once they had agreed on the revisions that were needed, was send the new plan to the ARPA Program Manager for approval. Most changes are done within the team by telephone calls.

One participant, reflecting a view shared by others, said that flexibility allows timely decision making. The steering committee for this participant's particular project works very well with the ARPA Program Manager. When they determine that a change is appropriate, they frequently can get the ARPA Program Manager's approval and go ahead and do it. This saves time and money. Both major and minor changes of direction are easily accomplished with no need to go to a Contract Officer and negotiate a contract modification as might be required under the FAR.

4.1.2 Use of Other Transactions Is "Enabling"

Participants in a number of projects that were of great importance to ARPA and to Defense needs in general reported that their programs were only possible under Other Transactions and would never have been attempted under the FAR. There were several reasons given for this. Commercial companies and other organizations vital to the success

of some programs were not able or not willing to function under FAR rules. Particular problems cited included the rigidity of mandated schemes for intellectual property sharing and protection, the intrusiveness and complexity of DoD-required accounting systems, and onerous requirements imposed on supplier-subcontractor relationships.

Companies who customarily protect their new inventions as trade secrets have difficulty with the requirements of the Bayh-Dole Act[1], applicable to procurement contracts, grants, and cooperative agreements, that all patentable inventions be disclosed and patented by the inventor or made available to the Government for it to patent.

Companies who operate in the commercial sector using accounting systems based on generally accepted accounting principles (so-called "GAAP systems") are not often willing to create separate, parallel, cost-based accounting systems for R&D contracting that comply with FAR-mandated cost accounting standards (CAS).

Companies with established long-term relationships with suppliers and subcontractors are reluctant to operate under requirements that suppliers and subcontractors be competitively selected at each step in an R&D effort where they are needed.

4.1.3 Consortium Organization Is Critical Under an Other Transaction

Participants consistently commented that getting a new consortium started is often difficult. Some early delays are due to lack of understanding by the participants about how to set up a consortium. Careful, deliberate planning of inter-company communications is needed. Care and time must be spent early in resolving difficult issues, such as intellectual property rights.

Program effectiveness was particularly affected by the initial start-up. Several respondents pointed to start-up problems leading to initial delays, poor administration, and reduced effectiveness in attaining program goals. Several suggested ARPA take a more active role in the start-up process by providing leadership and suggesting models for consortium structure and management. ARPA could have been a little more assertive up front, they said, to cut down on some of the early problems in getting things started.

Start-up delays were not always reported as a problem. In some cases, consortium members pointed to slow start-up as a necessary part of getting organized. One reported that in the beginning there were delays getting started because nobody knew how to get

[1] 35 U.S.C. §§ 201-212.

organized, but once the research effort got started, progress was good, implying—at least to this one respondent—that this was due in part to the time and care spent at start-up. Another reported that member companies spent a long time carefully defining the information content of each inter-company transaction. This effort smoothed the way for all levels of cooperation among the member companies of the consortium. It took a lot of up-front discussion covering such areas as intellectual property rights so that everyone would finally sign the agreement.

4.1.4 Other Transactions Are More Efficient

An efficient program is one that costs less, progresses more quickly, and attains its goal better than others of the same magnitude. Many of the participants interviewed said the work of their research consortia was more efficient than similar programs performed under the FAR. Technical progress is more rapid. Instead of spending project funds on non-value-added reports, they said they were able to spend them on the technical work. Some recipients reported having goals were near the utmost limit of what they could expect to achieve—and they were able to reach them.

One researcher said he had never seen a group work so well together. They were able to conduct their investigations at a much faster pace. Another said the Other Transaction "is a wonderful way to fund research efforts when you do not know in advance where you are going to end up." It allows participants to concentrate on getting the work done, not on program administration. Time is spent on technical work, not on non-value-added reporting. If the consortium works well together, the members can proceed at a much faster pace.

4.2 PROGRAM ADMINISTRATION

Participants were asked to consider how the use of an Other Transaction affected the way their organization administered its program. Program administration in this context chiefly meant managing the flow of funds, maintaining project schedules, and organizing deliverables and reports. We asked them to tell us if and how program administration was reduced and whether there were any areas where it was greater than they believed it should have been. We requested specific consideration of contract administration, overhead, accounting practices, reporting issues, and cost savings.

4.2.1 Simplicity Begets Savings

A typical FAR contract requires a contractor to provide for specialized contract administration as well as project-specific administration. One of the key aspects of the project administration requirements is a CAS-compliant cost accounting system. The Other Transaction mechanism eliminates the need for specialized contract administration, and substantially reduces the scope of project-specific administration.

Firms that have CAS-compliant cost accounting practices, methods, and tools typically continue to use them to support their work performed under an Other Transaction, simply because those systems are available. Firms that do not have CAS-compliant systems need not acquire them. One respondent reported that his firm chose to use its existing CAS-compliant system because the firm's accountants insisted on it, although it might have been easier to administer the project using a simple system developed on a personal computer using Microsoft Excel. While use of such a customized system might have added some development costs in the short term, it would have saved money in the long term through its simplicity and ease of use. Moreover, the development costs could have been recovered through use of the system in later consortia involving some or all of the same participants. The accountants' chief concern seemed to be allowing for a possible Defense Contract Audit Agency (DCAA) audit (even though the agreement did not provide for such an audit). This respondent reported that his firm knows that DCAA can audit non-conforming accounting systems because it has done so in other contexts.

The participants who were contacted in this survey enthusiastically endorsed the administrative simplicity engendered by the Other Transaction vehicle. It clearly reduces contractor overhead, which straightforwardly translates into cost savings, when compared to a traditional Government procurement contract.

4.2.2 Work Reporting and Work Payments Are Simplified

Interview respondents universally praised the great flexibility in reporting work progress and status to ARPA as a large point in favor of the use of Other Transactions.

4.2.3 Productivity of Research Workers Is Enhanced

Research scientists and engineers stated that the very nature of Other Transactions is such that the contract vehicle does not get in the way of conducting the research. The lack of a predetermined, overly detailed, rigid, and immutable Statement of Work is helpful. A good research team will always begin with a Statement of Work that is appropriately

detailed; the advantage of Other Transactions is that the Statement of Work can easily be altered as needed as the research progresses and the obtained results suggest new avenues for investigation.

4.2.4 Project Administration Differs

The consortia examined in this study employed three different ways for doing the basic administrative tasks. Two of the three paradigms—administration by team member and administration by "outside" contractor—were satisfactory. The third—administration by a university that was not otherwise a consortium participant—was barely acceptable, chiefly because it appeared to add cost without adding much value.

4.3 PARTNERSHIPS, CONSORTIA, AND TEAMWORK

Because most ARPA Other Transactions have involved consortia, participants were asked to consider how operating under an Other Transaction affected their relations with other members of their partnership or consortium. They were to consider:

1. Up-front "team building"
2. Management of the consortium
3. ARPA participation, whether as a partner, advisor, or customer
4. Mechanisms for resolving intra-consortium disagreements
5. Selection of partners
6. Sharing of information
7. Willingness of partners to do their assigned tasks
8. Level of trust
9. Commercialization implications

Participants indicated that a Memorandum of Agreement (MOA) needs to be worked out early on. The selection of partners is an important part of the process and must be part of the team-building effort. This is time consuming and should be completed prior to project initiation. If time is not allocated for this process, the first couple of months after project initiation become devoted to getting everyone on board and the real work of the consortium is delayed. When new members enter the partnership, they must be willing to sign up to the existing MOA.

Because the leader of the consortium plays an extremely important role, consortium organizers generally expend a great deal of effort to find the right organization or agency to lead the group. There appear to be instances where it is better to have an existing member of the consortium act as the leader if everyone else agrees. If this is not possible, then it becomes necessary to go outside the consortium to find a leader. This role as the leader of the consortium can sometimes be played effectively by a Government laboratory. These laboratories usually possess the necessary technical capability and can also act as an "honest broker" for ARPA and the Government. In some cases, two steering committees were established—a management group and a technical group. The management group conducted scheduled meetings or conference calls while the technical group met informally on an as-needed basis to solve day-to-day problems.

The degree of ARPA Program Manager involvement was considered just about right by most survey participants. In several cases when a Government laboratory was the leader of the consortium, the ARPA Program Manager had very little interaction with the consortium except at quarterly reviews. This degree of involvement was generally said to be adequate in most circumstances. When a member of the consortium was selected as the leader, the ARPA Program Manager would typically spend more time becoming involved in the process. This was especially true at the start up of the consortium. Some participants indicated that the ARPA Program Manager should have been more involved in their particular projects or should have interacted with a wider range of consortium members (not just the lead organization), but realized that the Program Manager's workload and involvement in other issues might have precluded greater involvement. Another important attribute of the ARPA Program Manager is the capability to remain flexible and allow for changes in the milestones as the research agenda changes. This capability enables ARPA Program Managers to work with consortium management committees to restructure an R&D effort easily when necessary and to improve the overall scheduling process in real time.

Consortium governing agreements generally provided a formal mechanism for resolution of disputes among partners. These procedures were seldom used. In most instances, discussion and persuasion leading to consensus were the preferred form of conflict resolution.

Partner selection was recognized as a critical element in every consortium, but identification and selection of the right partners were not regarded as problems. Each

consortium evolved methods for determining who to include, some with guidance from an ARPA Program Manager about a source for a particular capability that was needed.

The overall sharing of information and level of trust were reported to be generally excellent. Careful planning of inter-company activities in the initial stages of a consortium allowed for some creative solutions for this potential problem area. From the standpoints of cooperation between traditional competitors and the pooling of resources, Other Transactions worked extremely well once the initial negotiations were completed and an MOA was signed by all the members of the team. As time went on, concern about competitive information seemed to diminish as the consortium began to build a level of trust that enabled the sharing of necessary information.

Respondents reported no particular problems with consortium members being either unable or unwilling to do their assigned tasks. Where such problems arose, they were handled within the consortium management framework by applying appropriate forms of persuasion or by reassigning the work to other members and giving the non-performing partner other appropriate work to do instead.

Consortia have spawned new projects, relationships, and other business ventures as a result of the working relationships and rapport that have been established by virtue of Other Transaction agreements. A high level of trust usually develops among the members of a consortium that makes the sharing of information much easier. Most of the participants felt that the learning curve required to conduct the team building efforts would be minimized the second time around. As a result of their experience participating in consortia under Other Transactions, some universities and companies are becoming pro-active in setting up working agreements to allow students the opportunity to observe how companies operate in the real world and even obtain part-time employment that could lead to future full-time employment.

4.4 MECHANISMS FOR REVIEWING PROGRESS AND MAKING PAYMENTS

Participants were asked to consider:

1. the mechanism by which the ARPA Program Manager monitored the progress of their project,
2. the importance of "payable milestones",
3. the method of receiving payments,

4. the timeliness of payments, and

5. other possible mechanisms to review progress that they might recommend.

Researchers were pleased with the ability to establish milestones up front and to base progress payments on attaining milestone objectives instead of reporting cost as a payment metric with a set of fixed deliverables. Milestones were established within each consortium by members with expertise in the research area. As research progressed, future milestones were adjusted to reflect knowledge gained in previous phases.

4.4.1 Milestone Flexibility

Unlike fixed deliverables, milestones are easy to change when required by an evolving research agenda. They are more compatible with researchers' application of "best engineering judgement" than are fixed deliverables. Participants reported that the flexibility of their agreements made it easy to change the schedule and milestones when it was necessary. Some respondents said they rewrote the schedule each year based on the prior year's results. If changes were needed, they simply worked them out through the consortium management process and then with the ARPA Program Manager.

4.4.2 Payable Milestones

Most said payable milestones are far better than cost-based payments tied to fixed deliverables. Milestones can be a driver, the drumbeat, keeping the work on track, creating a series of "mini-fixed-price contracts." Some respondents said payable milestones forced them to produce on time. They liked the fact that they could set tasks early with clear milestones and a set of deliverables instead of cost-based work.

While payable milestones were generally lauded, one respondent pointed out that they must be carefully designed to provide an adequate flow of funding as research progresses. Payments must be both reasonable and timely.

4.4.3 Reporting Requirements

Participants said that reporting progress was much more important and appropriate than reporting costs. Other Transactions allow organizations to report what they have done in the way of productive work—what has been accomplished during the reporting period. Reporting becomes aligned to the goals of the program, and becomes a meaningful summary of progress. Reporting of costs incurred is not important because the organization

is being paid for progress in research, rather than simply being reimbursed for its expenditures.

ARPA reporting requirements, characterized by participants as minimal but adequate, yield cost savings. Respondents see overhead savings from less-than-extensive reporting requirements and regard this as a more efficient way to operate. Once every few months was deemed by respondents to be about the right frequency for face-to-face meetings with the ARPA Program Manager.

4.4.4 Payment Promptness

This is an area that could use some correction. While some participants reported extremely prompt payment, others suffered from extremely slow payments. Where there have been problems, some have been with a consortium administrator, some with ARPA, some with a payment office elsewhere in DoD or in some other Government agency. Reports about the promptness of payments ranged from glowing praise to bitter complaints. All these seem to point to policy and practice problems and not disagreements between ARPA and participants over milestone completion.

Both Government and private sector administrators unfamiliar with milestone payments under Other Transactions were cautious and sometimes slow in paying. At the same time, lead companies and Government agencies in some of the programs were praised for their payment promptness. As part of its defining model, some respondents suggested ARPA should include guidance for organizations and agencies that process payments to consortia and their members.

4.5 FOREIGN ACCESS TO TECHNOLOGY

Each ARPA Other Transaction agreement includes a provision limiting foreign access to technology developed under the agreement and requiring participants to disclose any planned foreign access to ARPA for review and consent. The purpose of this provision is to assure that the principal economic benefit of ARPA funding accrues to the economy of the United States. Respondents were asked to assess the effect of the restriction on their project by considering four questions:

1. Did you have plans for foreign access to technology—including, possibly, having non-U.S. firms in your partnership—before entering into the agreement?
2. Were any restrictions on foreign access imposed on you by ARPA? Were they onerous? Did they require changes in project plans?

3. Did your plans for foreign access change during the project?
4. Did you have occasion to negotiate with ARPA over foreign access issues? Were the negotiation process and the results satisfactory?

The ARPA provision described previously does not address the use of foreign nationals as researchers, a common occurrence when universities participate in projects under an Other Transaction. Some respondents noted this as an area of concern to them that was apparently not of concern to ARPA, despite ARPA's general concern that the benefits of its research funding accrue principally to the U.S. economy.

Some participants reported problems related to participation in their consortia by foreign-owned firms. In at least one case, a foreign-owned firm that initially planned to participate ultimately dropped out because issues related to its foreign ownership would not permit it to agree to limit foreign access. In another, a participant was being acquired (at the time IDA interviewed participants) by a foreign firm after the consortium's project was well under way and other consortium members were anticipating problems as a result. In a third case, a major consortium participant was a Japanese-owned firm that conducted all of its business in the United States, which caused some nervousness on the part of other participants.

Because the ARPA-required provision provides a mechanism for a consortium to notify ARPA of a proposed foreign access and obtain ARPA's consent, it appears to have afforded sufficient flexibility to allow the respondents to deal with changes in their plans for foreign access. In at least one case, the strong business interests of one participant in transferring consortium-funded software overseas were recognized first by the consortium and then by ARPA. The result was an agreement allowing the software to be sold overseas earlier than the original Other Transaction would have allowed, subject to a restriction that it be provided solely as object code.

4.6 INTELLECTUAL PROPERTY RIGHTS

Respondents were asked to discuss the effect of working under an Other Transaction on the allocation of rights in intellectual property (such as patents and copyrights), and how this vehicle affected their ability to protect existing proprietary property used in the performance of work with program partners.

They were specifically asked to consider:

- the ability (or inability) of the consortium to allocate and share intellectual property,
- the process by which the allocation was determined,
- the consortium's ability to address problems in this critical area, and
- access to technologies that would otherwise not have been available.

Also relevant to this area was the relationship between consortium materials and the Freedom of Information Act (FOIA). Some respondents noted that ARPA and other Government agencies involved went to some lengths to arrange for the proprietary information of consortium participants to be protected from disclosure under FOIA. This was usually accomplished by avoiding actual delivery of such materials to the Program Manager, although provision was made for the Program Manager to review them on the premises of some consortium member.

In general, respondents reported either that the patent rights regime imposed under the Bayh-Dole Act (which is the mandated regime in all contracts, grants, and cooperative agreements) that is the "ARPA default" for Other Transactions posed no difficulty for them, or that ARPA showed sufficient flexibility to develop a different allocation of rights that was acceptable to all parties. For those consortia that included participants who customarily chose to protect their intellectual property as trade secrets, the availability of an intellectual property rights regime that did not require patenting was the key provision of an Other Transaction that made the particular project possible at all.

4.7 POTENTIAL FOR FRAUD, WASTE, AND ABUSE

ARPA's Contracts Management Office asked IDA to query participants about their view of the risk of fraud, waste, and abuse under Other Transactions as compared to the risk under agreements governed by the FAR. All who responded said that the level of risk involved in operating under Other Transactions was no greater than operating under the rules of a Government procurement contract.

One common response was that in a consortium made up of many entities including universities, Government laboratories, and industrial firms, there is less of a chance for potential fraud, waste, or abuse violations since there is always someone "looking over each participant's shoulder." Respondents generally said that the members of a consortium have the ability to monitor one another and, as a result, to minimize the risk for these types of problems.

Requiring members of a consortium to share the costs of the project was recognized as a great inhibitor to waste. Organizations are less likely to tack on costly overhead activities when they have a financial stake in the process. Although cost sharing presented a financial hardship for a number of companies, it has proven to be a true test of a company's commitment and has weeded out some consortium members who were unwilling to back up their "commitment" with funding.

Bringing on board an "outsider" just to act as an administrator for the consortium appeared to be a wasteful choice. In one consortium this was done because none of the members wanted the task of consortium administrator. Several companies in this consortium nevertheless felt that the addition of this "outsider" was an expensive way to conduct business and not money well spent.

4.8 COST SHARING

Cost sharing emerged in participant responses as a significant area of concern, even though it was not explicitly addressed in the discussion questions sent out by IDA. The burdens and benefits of cost sharing reveal a wide range of attitudes on the part of consortium members. There were many reports of praise for the practice and many complaints.

Cost sharing is generally regarded as a test of commitment. Respondents suggested that if an organization is not interested in an area enough to share costs, then perhaps it should not pursue opportunities in that area. This was seen as a question of "putting your money where your mouth is." For some, cost sharing was deemed appropriate because, they said, the effort was a "worthy project" for their company.

4.8.1 Drawbacks

Companies and laboratories that had to come up with matching funds had a problem if the money was not available. Even some larger companies have trouble in this area. One company suggested ARPA consider a liberal interpretation that allows for a prorated share for small companies.

Larger companies sometimes had to "foot the bill" for their smaller consortium partners. In return, in some cases, they wanted some form of *quid pro quo*. This put the smaller companies at a disadvantage because such "paybacks" can sometimes create uncomfortable "debts."

One traditional Defense contractor reported that funds for cost sharing in his company could only come from profit (fee) or internal R&D. Profits in cost-type Government contracts are limited by law. There is much competition within such companies for internal R&D funds, and these funds are often reserved for those research programs that are expected to lead to Government production contract opportunities. This limits the amount of funds available to traditional Defense contractors for cost sharing on other kinds of research efforts.

4.8.2 Advantages

Some participants reported that cost sharing can help keep highly talented company employees busy at times when the company's own research efforts are not sufficient to occupy them. Involvement in a cost-shared project allows a company to keep its staff productively occupied *on projects of value both to it and to ARPA* for "half price."

One participant reported that this approach can backfire if a project is outside of a company's core competence. Companies working outside their core competence, and therefore without a strong vested interest, lose their intensity. Their work and the cost sharing arrangement simply cover otherwise idle employees. Their contribution is then of less value to the Government and to the consortium.

Participants reported that company R&D dollars can go much farther if they are cost shared with the Government. Companies can undertake needed research programs and the Government foots half the bill. Some smaller companies can stretch even farther by using the resources of their larger partners. Cost sharing can be a great advantage for small companies that usually do not have a large R&D budget because they are oriented toward production. This process allows these companies to utilize the resources of large companies to assist them to participate in the R&D arena.

4.8.3 In-Kind or Cash

There were several calls for flexibility in allowing in-kind (non-cash) cost share. According to one respondent, his management is overly sensitive to hardware cost vs. software cost and cash cost sharing vs. in-kind cost sharing. The company spent $50,000 to solve a problem using people and software instead of buying hardware, even though they knew the hardware would cost a lot less. This participant suggested ARPA buy hardware and let companies provide people.

In several programs, ARPA received more cost share value than it required. In one case, ARPA initially committed to put up about 12% of the cost of the project. The consortium collected the rest from its other members. *An important difference in this program is that the costs shared by participants were only in the form of cash.* Most members also provided in-kind contributions, effectively reducing ARPA's share of costs, but none of them was counted in calculating cost share to meet the contractual (or statutory) requirement.

Another frequent occurrence was the provision of additional resources by consortium members after the project was in progress, reducing the ARPA share below initial estimates and statutory requirements.

4.8.4 Adjustment for Risk

Some respondents suggested that where an organization's risk is higher, its share of cost should perhaps be lower so that the Government takes on more of the risk. A consortium member, willing to participate, may bring a valuable expertise to the program. In some cases, the cost share may be great and the benefit to the program valuable but the return for the participant carries considerable risk. Some suggested the Government take this into account and reduce the required share of cost to offset the risk. Ratios other than 50/50 may be appropriate in higher risk projects and some exceptional cases should perhaps require no cost sharing.

4.9 SUGGESTIONS FOR IMPROVEMENTS IN THE USE OF OTHER TRANSACTIONS

A number of suggestions were made by persons interviewed about possible improvements. This is not to imply that the Other Transaction was believed to be ineffective. Rather, the suggestions were offered in order to make something they perceived as being good even better.

4.9.1 Outsider in Consortium Can Help Keep the Playing Field Level

Some interviewees expressed a belief that having an outsider, for example, ARPA or a Government laboratory, as a non-voting member of a consortium could help to keep the playing field level by acting as referee in inter-company clashes with respect to trade secrets or other intellectual property issues. This could be a good role for a Government laboratory, either one of the Defense Department laboratories (such as Wright, Rome, the Army Research Laboratory, or the Naval Research Laboratory), or one of the Energy

Department Laboratories (such as Sandia, Los Alamos, or Argonne). ARPA sits as a non-voting member in both the management oversight committee and the technical oversight committee of one consortium. As always, the real value brought to the table depends heavily on the skills, education, and experience of the person or persons selected to represent the Government. The management oversight committee for this consortium has retained and makes use of a support contractor who collects reports, distributes funds, and arranges for teleconferencing and multi-media conferencing. In this particular case, although not in all, the presence of such a support contractor helps to reduce or eliminate resentment among the team members.

4.9.2 ARPA Should Use Prorating Scheme for Small Firm Cost Sharing

The interviews indicated that small firms often have difficulty in matching Government funds. Several persons interviewed expressed the opinion that ARPA could relieve this problem by using a prorating scheme, requiring less than 50% of costs from small businesses.

4.9.3 Consortia Members Wish to See the ARPA Program Manager More Often

Several organizations interviewed would have preferred to see the ARPA Program Manager more often. In some consortia the ARPA Program Manager dealt with the lead firm but not with the non-lead firms; some of these firms would appreciate being able to discuss technical and programmatic issues with the ARPA Program Manager on a relatively regular basis.

4.9.4 ARPA Should Be More Pro-Active in Consortium Start-Ups

Several organizations expressed the opinion that ARPA should have a generic MOA available for distribution to all members of a consortium, and, further, that ARPA should get involved and get the information flowing early on. Most successful consortia have clearly and succinctly defined their information sharing transactions; in fact, this is the essence of any workable collaboration. Many participants believed that ARPA should initiate and facilitate this definition process from the beginning.

5. FINDINGS AND CONCLUSIONS

5.1 POSITIVE FINDINGS

Other Transaction participants who responded to IDA's request for information reported a number of areas in which they viewed the Other Transaction as a superior funding vehicle for Government-sponsored R&D efforts. In general, IDA found these responses to be credible in light of IDA's experience with ARPA-sponsored research efforts and other Government-funded R&D.

There was almost universal praise for the effectiveness of the Other Transaction at allowing R&D to go forward efficiently. A number of respondents reported that the use of an Other Transaction enabled research efforts that the participants involved would not otherwise have undertaken. Respondents also noted the flexibility of the arrangement, which made re-directing research efforts easy when it was necessary. They also frequently reported that it was easier to become more efficient under an Other Transaction than in their other Government-funded research efforts.

Most respondents reported that program administration was generally simpler than under procurement contracts or cooperative agreements. Other Transactions reduced the administrative burden on the participants, making it less of an intrusion on the actual R&D effort.

Participation in an Other Transaction has generally also meant participation in a partnership or consortium. While some participants found the collaboration experience difficult, they did note that the consortium structure made possible information sharing based on mutual trust. Consortia can be self-governing and resolve their own problems without recourse to contract dispute mechanisms. Learning how to operate in a consortium framework as the result of an Other Transaction has sometimes led to new business opportunities. Most also felt that the level of ARPA program manager involvement in their consortia was just about right.

ARPA's use of payable milestones as the mechanism for progress review and payments was universally well regarded. Participants particularly took note of the

flexibility of the mechanism and its tendency to keep a project moving forward, much like a "series of 'mini-fixed-price contracts.'" Generally, payable milestones and the flexible reporting requirements used with them were regarded as allowing participants to report *progress*, as opposed to "merely" reporting expenditures.

Foreign access to technology was generally not an issue for the responding participants. Either the issue did not arise in the context of their particular project, or ARPA's standard approach and agreement language were sufficiently flexible to meet the participants' needs. IDA is aware that ARPA's experience in some later projects not included in the survey indicates that there can be serious problems in this area, particularly with large multi-national manufacturing firms. ARPA considers its policy on foreign access to be required by law and an otherwise prudent approach for an R&D funding agency that wants to ensure that the principal economic benefit of its efforts accrues to the United States economy.

ARPA's flexible approach to the allocation of intellectual property rights, based in the legislative exemption of Other Transactions from the requirements of the Bayh-Dole Act, made a favorable impression on most participants. In general, Other Transaction participants either could operate within the requirements of Bayh-Dole or were able to reach an accommodation with ARPA that allowed a different intellectual property rights regime for their projects. ARPA's flexibility with respect to the delivery of reports containing proprietary information also met with favor among respondents because it allowed them to avoid potential difficulties raised by the Freedom of Information Act.

Participants viewed Other Transactions as no more likely to encounter waste, fraud, or abuse than other kinds of Government agreements. They saw the use of consortia as creating a self-monitoring environment that tends to prevent "misbehavior" by individual participants. They saw cost sharing as an inhibitor to waste, and they saw no increased risk of fraud, waste, or abuse resulting from the absence of the many "protective" rules applicable to procurement contracts.

Cost sharing also drew favor as an effective mechanism for assuring some level of commitment on the part of project participants. It can allow a firm to have higher-quality employees than it could afford using only its own funds, and it can provide a way to do research of interest to the company, with ARPA "paying half the cost."

5.2 NEGATIVE FINDINGS

The largest area of complaint among respondents was that forming a consortium is difficult and time consuming.[1] Partnering is a relatively new concept for American industry, no less in the Government-funded R&D arena than in any other. Participants particularly noted that critical decisions needed to be made early, that a detailed MOA was important to clearly establish the roles and responsibilities of all players, and that the choice of a consortium leader was critical to the success of the venture.

Respondents often complained of difficulty in finding the right entity to perform the needed project administration tasks, whether that entity was a consortium participant, a non-participating interested firm, or a disinterested third party such as a university or Government laboratory.

Prompt payment was commonly reported as a problem, despite the flexibility of the billable milestone payment method. Problems were reported with ARPA and with various disbursing agents in the consortia themselves or in Government agencies performing this function on ARPA's behalf.

Some participants had concerns about participation of foreign entities in their consortia in light of ARPA policy with respect to foreign access to technology. Some expressed concern about the participation of foreign students and foreign employees of consortium participants, despite the lack of ARPA concern with this particular aspect of the foreign access issue.

Cost sharing also was regarded as having negative aspects. It is often very difficult for small firms to come up with their share of costs. Traditional defense contractors also felt disadvantaged by the need to share costs. Some complained that the pool of money available in their companies for research was limited to internal R&D and some portion of fee. This pool was subject to many competing demands, and priority was often given to projects that were deemed likely to lead to future production contracts. There was a concern that the availability of the Government's share of costs could lead a company to seek

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[1] Consortium formation is clearly an area that the participants believe needs greater attention. ARPA's later experience in the TRP reinforces this belief. When ARPA set out to provide information in lieu of debriefing to the 2,500 unsuccessful proposers in the first TRP solicitation in 1993, it did so by enlisting private sector experts on partnering and consortia to present a two-day conference on that subject. The lack of appropriate attention to partnership formation and structure was the single most common deficiency in TRP proposals at that time. What is not clear is whether assistance in consortium formation should appropriately come from ARPA.

participation in an area outside of its "core competencies" just to get the Government share of funds.

5.3 PARTICIPANT SUGGESTIONS

Participants suggested some improvements in ARPA's use of Other Transactions. Chief among these were the consistent use of an outside entity (ARPA program manager or Government laboratory representative) as a non-voting consortium member who can "referee" disputes. Many suggested a relaxation of cost sharing requirements either to enable more small business participation or to more appropriately allocate risk between the Government and the consortium. To ease the starting up of new consortia, several suggested greater ARPA involvement in consortium building and ARPA-provided start-up guidance for new consortia.

5.4 CONCLUSIONS

The flexibility offered to researchers by the use of an Other Transaction is viewed by the participants as a real advantage over traditional Government contracting methods. A research direction can be changed by a simple decision of the consortium governing body, concurred in by an ARPA Program Manager, without time-consuming and costly contract modifications. Unfortunately, "unfettered" flexibility—that is, increased flexibility not balanced by an appropriate degree of accountability—may increase the risk of waste. One way to view some provisions of the FAR and DFARS is that they reduce the need for accountability (and, therefore, the potential for fraud, waste, and abuse) by providing rules that limit flexibility. ARPA's approach, that regulation can be replaced by choosing good people and making them accountable for their decisions, is clearly shared by the participants in this survey. Instead of rules, ARPA provides accountability in the form of Program Managers who generally maintain a high level of involvement in their projects, and appropriate oversight of those Program Managers by ARPA management. Further, ARPA "arms" itself with a walkaway termination clause to make it easy to end an unproductive project with a minimum of waste and bother.

Although cost sharing for Government-sponsored R&D appears to be widely disliked, it generally appears to fulfill its purpose of requiring non-Government participants to demonstrate their commitment to an R&D effort, and there seems to be no better alternative mechanism for assuring such commitment. However, small businesses claim that having to match the Government dollar for dollar makes it all but impossible for them to participate. Cost sharing is unpopular. This does not mean that ARPA should not

continue to require it. Still, variances from a rigid requirement for 50/50 cost sharing may be appropriate in some cases either to attract certain entities such as cash-poor small businesses to participate, or because the technical or business risk is greater than usual, making a greater Government share of the cost burden more appropriate. There is some risk, however, of weakening the usefulness of cost sharing as a test of commitment by accepting "in-kind" forms of cost sharing that are of questionable value to the R&D project or whose value may be difficult to assess.

APPENDIX A. PROJECTS INCLUDED IN IDA SURVEY

Those participants who responded to the IDA survey appear in italics.

Projects Included in IDA Survey

Consortium	Project	Participants
Investment Casting Cooperative Arrangement	Precision Investment Cast Components	*Howmet Corporation* *General Electric Aircraft Engines* *Precisions Castparts Company* *Pratt & Whitney* *Universal Energy Systems*
Ferrite Development Consortium	Micromagnetic Components	*George Washington University* *EMS Technologies* Raytheon Trans-Tech, Inc. *Westinghouse* *MIT Lincoln Laboratory* National Institute of Standards and Technology *Naval Research Laboratory*
Smart Materials Consortium	Insertion of Smart Materials into Military Systems	AVX Corporation *Martin Marietta Laboratories* Martin Marietta Astronautics Group Lockheed Missiles & Space Center *BDM, Inc.* Clemson University University of Maryland College Park Johns Hopkins University University of Denver TIMET Corporation Virginia Polytechnic Institute and State University Pennsylvania State University *Naval Research Laboratory*
N/A	a	*3M Corporation*

a. 3M was not a participant in any of the ARPA-funded Other Transactions included in this survey. However, it has been involved in subsequent Other Transactions and its legal staff has been particularly forthcoming in addressing in meetings and publications the difficulties a commercial company encounters in trying to do Government-funded R&D. 3M was included in this survey at the suggestion of the ARPA General Counsel

Projects Included in IDA Survey (Continued)

Consortium	Project	Participants
Affordable Polymeric Composite Materials	Affordable Polymeric Composite Materials	*McDonnell Douglas* BP Chemicals *Production Products, Inc.* Virginia Polytechnic Institute and State University *Washington University* Zoltek Corporation Naval Research Laboratory *Heath Techna Aerospace*
N/A	Active Matrix LCD Manufacturing	*Optical Imaging Systems*
Materials Synthesis Consortium	Advanced Molecular Beam Epitaxial Technology	Hughes Research Laboratories Texas Instruments *EPI/Chorus Corporation* *Superior Vacuum Technology* J.A. Woollam Company University of Colorado *University of New Mexico* University of Southern California University of Virginia *Sandia National Laboratory*
(Unnamed)	Advanced Photorefractive Nonlinear Optical Material	Optitek IBM GTE Hughes Aircraft Company Hoechst-Celanese Rockwell International Stanford University SRI International
Optical Network Technology	Ultra-Fast, All-Optical Communications Systems	*NORTEL Federal Systems* *BellSouth Telecommunications* Georgia Tech Research Corporation Columbia University
Display Materials Consortium	Visible Vertical Cavity Surface Emitting Laser Materials	Bandgap Technology Corporation *Brown University* *Purdue University* *Colorado State University* *Photonics Research, Inc.* *Sandia National Laboratory*
U.S. Display Consortium	High Definition Display Manufacturing Technology	AT&T Xerox Palo Alto Research Center *Optical Imaging Systems, Inc.* Standish Industries, Inc. American Display Corporation

Projects Included in IDA Survey (Continued)

Consortium	Project	Participants
IHPTET	Advanced Ceramic Fibers for High Temperature Engine Components	*General Electric Aircraft Engines* United Technologies - Pratt & Whitney Allied Signal Garrett Engine Division *GM Allison Gas Turbine Division* Textron - Lycoming Division Williams International Teledyne CAE
(Unnamed)	Massively Parallel Supercomputers	*Cray Research Corporation* *Sandia National Laboratory*
(Unnamed)	Concurrent Supercomputing	*Intel* *California Institute of Technology* *NASA Jet Propulsion Laboratory*

APPENDIX B. TEXT OF LETTER SENT TO POTENTIAL STUDY PARTICIPANTS BY ARPA DIRECTOR

Dear [OT Participant]:

Since 1989 ARPA has had the authority to enter into contractual arrangements—called Other Transactions—with its private sector R&D partners that offer greater flexibility and reduced administrative burden when compared with the typical Government contract. Congress granted ARPA this authority in recognition that procurement contracts are an inappropriate vehicle for science and technology contracting, a principle recognized in the Federal Acquisition Regulation (FAR) itself. Grants and cooperative agreements are generally suited for public purposes like the advancement of science and technology. However, Congress recognized that there are situations faced by ARPA in which even the availability of these agreements does not provide sufficient flexibility for every ARPA research venture.

Since being given its other transaction authority, ARPA has entered into some forty such agreements, including at least one involving your organization. Most of these have involved partnerships or consortia, either already existing or formed specifically to conduct a particular ARPA-sponsored research or development effort.

In these times of shrinking Defense budgets, it is imperative that ARPA make the most effective use possible of its resources to fund the development of technologies crucial to national security. I believe that other transaction authority is a vital cornerstone of ARPA's ability to do this. I have asked the Institute for Defense Analyses (IDA) to

undertake a survey of organizations that have participated in other transactions to elicit those organizations views of the benefits (and drawbacks, if any) of this extremely valuable tool. Because of your experience as a participant, your opinions and any supporting information you can provide are vital to this effort. We need to understand and document the efficacy of other transactions so that we can continue to sponsor private-sector research in the best possible way.

You will be contacted shortly by a representative of IDA to request your cooperation in this review. I, and all my colleagues at ARPA, would greatly appreciate your taking the time to respond to IDA's questions as fully and as expeditiously as possible.

Regards,

Dr. Gary L. Denman
Director

APPENDIX C. TEXT OF LETTER SENT TO POTENTIAL STUDY PARTICIPANTS BY IDA

Dear [OT Participant]:

ARPA has statutory authority to enter into agreements for research and development that are not standard Government contracts, grants, or cooperative agreements. These agreements, known as Other Transactions, are outside the normal procurement system. Your organization participated in one of these agreements as part of the [Program].

ARPA has tasked the Institute for Defense Analyses (IDA) to contact organizations who have participated in other transactions to see what these organizations believe the benefits and drawbacks (if any) have been. The results of these efforts may be included as part of a report being prepared by ARPA. IDA and ARPA would greatly appreciate your help.

Enclosed is a list of suggested topics with a little discussion on each to help get us started. Because we would like your response to encompass the broadest possible range of benefits your organization derived and drawbacks you may have noted, we encourage you to discuss these questions with people in other areas of your organization who were affected, perhaps including your contracts, finance, or legal staffs. The suggested topics are:

Effectiveness of programs conducted under ARPA other transactions,

Program administration,

Partnership, consortia, and teamwork,

Mechanisms for reviewing progress and making payments,

Foreign access to technology, and

Disposition of intellectual property rights.

IDA researchers will contact you beginning the middle of February to set up a convenient time to review the discussion topics. If you have any questions, please call me.

ARPA needs to know your detailed opinion of these other transactions so that they can generate the best and most efficient vehicle for sponsoring research efforts. We greatly appreciate your taking the time to participate in the study.

Sincerely,

Michael S. Nash
Institute for Defense Analyses

Enc: Copy of letter from Dr. Gary L. Denman
Suggested Discussion Topics

APPENDIX D. DISCUSSION QUESTIONS SENT TO POTENTIAL PARTICIPANTS BY IDA

Suggested Discussion Topics

We have developed the following six topics to help start our discussions with you and your organization. Each topic is presented separately below, along with a brief statement of what we mean by the topic and a few ideas to start the conversation. *We strongly encourage you to add topics for our consideration. We believe you, as a participant in one of the actual ARPA agreements, are in a very good position to uncover important ideas that we should consider.*

Please go over these topics and, if appropriate, discuss them with some of your colleagues. When we set up our discussion with you, you are welcome to include other people as you feel appropriate. We look forward to hearing what you have to say.

1 Effectiveness of Programs Conducted Under ARPA "Other Transactions"

We want to know how well you and your organization feel the ARPA "Other Transactions" work compared to the more traditional contracts under the Federal Acquisition Regulation (FAR)[1]. We are interested in your experience using "Other Transactions" and your opinion about other possible uses of this type of agreement.

To help focus your thoughts, consider the following ideas as a point of departure:

- The reasons the "Other Transactions" agreement seemed to work (or not work) for you.
- Your involvement with ARPA—and with any agencies other than ARPA—with this type of arrangement, as compared to traditional contracts governed by the FAR.

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[1] If you or your organization have no other Government contracts, then please consider this topic and your "Other Transactions" in the context of similar commercial arrangements.

- Both the strong points and problems encountered utilizing the "Other Transactions" agreement in terms of business issues (the contract and its administration), managerial issues (the consortium and research project and their administration), and technical issues (the performance of the technical tasks).

2 Program Administration

We would like to know how the use of "Other Transactions" affected the way your organization administered your program. We want to know how program administration burden was reduced and whether there were areas where more administrative effort was required.

Areas to consider under this heading include:

- Contract administration,
- Overhead,
- Accounting practices,
- Reporting issues, and
- Cost savings.

3 Partnerships, Consortia, and Teamwork

If your organization's "Other Transaction" called for work by a partnership or consortium, we want to know the impact of using the "Other Transaction" on the way your organization worked with other members of the partnership. In what ways were relations improved and in what ways otherwise affected?

Considerations should include but not be limited to:

- "Team building" up front to make for a more efficient process,
- Management of the consortium,
- ARPA participation as a "partner" or a "customer" as far as involvement and supervision, and the nature and appropriateness of ARPA's role,
- Mechanisms for resolving intra-consortium disagreements,
- Selection of partners (to be included or excluded),

- Sharing of information,
- Each partner "pulling" his load,
- Level of trust, and
- Commercialization implications.

4 Mechanisms for Reviewing Progress and Making Payments

We want to address methods of establishing and measuring program milestones and how they are used in determining progress payments in programs under "Other Transactions" compared to those under the FAR.

In this regard, you should consider:

- The mechanism by which the ARPA program manager monitored the progress of the project,
- Importance of payable milestones,
- Method of receiving payments—directly from the Government or through the consortium,
- Timeliness of payments to allow work to proceed, and
- Other possible mechanisms to assess progress.

5 Foreign Access to Technology

Working under an ARPA agreement required you to limit foreign access to technology developed under the agreement and to disclose any planned foreign access to ARPA for review and consent.

- Did you have plans for foreign access to technology—including, possibly, having non-U.S. firms in your partnership—before entering into the agreement?
- Were any restrictions on foreign access imposed on you by ARPA? Were they onerous? Did they require changes in project plans?
- Did your plans for foreign access change during the project?
- Did you have occasion to negotiate with ARPA over foreign access issues? Were the negotiation process and the results satisfactory?

6 Disposition of Intellectual Property Rights

We want to know the impact on the allocation of intellectual property derived from work conducted under "Other Transactions." We are interested in how this vehicle affected your ability to protect existing proprietary property used in the performance of your work with program partners.

Considerations should include:

- The ability (or inability) of the consortium to allocate and share intellectual property,
- The process by which the allocation was determined,
- The consortium's ability to address problems in this critical area,
- Access to technologies that would otherwise not have been available, and
- Realizing that this area can be one of the most difficult for the consortium to agree upon, we are interested in any thoughts you may have regarding disposition of intellectual property rights.

LIST OF ACRONYMS

ARPA	Advanced Research Projects Agency
CAS	Cost Accounting Standards
DoD	Department of Defense
DCAA	Defense Contract Audit Agency
DFARS	Defense Federal Acquisition Regulation Supplement
FAR	Federal Acquisition Regulation
FOIA	Freedom of Information Act
GAAP	Generally Accepted Accounting Principles
IDA	Institute for Defense Analyses
IHPTET	Integrated High Performance Turbine Engine Technology
MOA	Memorandum of Agreement
PC	personal computer
R&D	research and development
TRP	Technology Reinvestment Project
U.S.C.	United States Code

Mr. HALL. With that track record is that authority something that NASA should make more of a use of, in your opinion? We'll ask Ms. Lee. Or are there considerations that would limit that usefulness? And I'll kind of tell you what I'm thinking about there as to whether or not there would be some situations where Congress might react if the government finds that an innovative contract has exposed them to greater losses or instances where high risk research and development activities did not pay off.

Mr. DUNN. Again, I'm loath to tell NASA what it should do but I will tell you that as counsel to the Space Commercialization Task Force at NASA in the early 1980s I personally recommended that NASA make expanded use of its Space Act agreements authority.

Again, the issue of are there more risks, our participants have expressed their opinion on that. It's a different way of doing business. You have to have a lot of self interest built into it. You can't do everything this way but you have to look for opportunities to do things a different way.

I think your concerns are absolutely apropos and we have integrated other transactions into our quiver. It is one arrow in our quiver. We issue procurement contracts, we issue grants to universities, we generally don't do cooperative agreements. We do other transactions. We pick those cases which we think are best suited to the particular instrument involved and the degree of flexibility that we need.

Mr. HALL. Inasmuch as my time certainly has over-expired I presume Ms. Lee basically agrees with the statements you made.

Ms. LEE. Yes, sir, we are. Again, a good analogy: one tool. NASA is certainly looking to use those that are appropriate for different circumstances. What we don't want to do is get to the point where we use one approach. I think we really need to be at the point where we look at each individual activity and say what is the best approach for this activity.

Mr. HALL. I thank you the chair.

We had problems at Texhoma with the Corps of Engineers following the law to the letter and they had no flexibility at all on flood release. If they released too much they flooded the sugar beet farmers below and if they didn't let the flow go they flooded the Morenas there.

I simply put a provision in the Act that they could use their common sense and it's worked okay ever since. The problem is when you use your common sense and it comes back home to you adversely. But those are the risks we take in progress.

And I yield back my time. I'll keep on talking if the chairman's busy.

[Laughter.]

Mr. HALL. He seems to have a better deal.

I yield back my time, Mr. Chairman.

The CHAIRMAN. Thank you, Mr. Hall. I'm sorry, I was engaged in another conversation there.

Mr. HALL. I used to do that when I was chairman long ago.

The CHAIRMAN. Thank you.

Mr. Doyle.

Mr. DOYLE. Thank you, Mr. Chairman. Thank you for holding this hearing. I apologize that some other commitments caused me

to be late and miss some of the speakers. I just want to pose a couple of questions to Mr. Rogers. I found his testimony interesting.

I wonder if you could just discuss a couple of things. Number one: what gives you confidence or what do you see out there to indicate that private companies would want any part of the space station? And I'm also interested to learn if you've talked to NASA, you know, about some of the business concepts that you've talked about for operating the space station and what their reaction has been to some of your ideas.

Mr. ROGERS. There have been in the last few years two studies made of the potential opening up of space business, if we get the costs down. If I don't do anything else here today, I want to leave you all with the clear knowledge of the paralytic costs of basic space infrastructure and activities. They rank between 1,000 and 100,000 times the costs here at the Earth's surface.

So the highest priority in the civil space area, if we have any ambitions whatsoever of large-scale commercialization of space outside of the information areas of communication, remote sensing—we must get those costs down. And I don't much care whatever else does go on in the Federal civil space program. If we get those costs down, business will burgeon.

We've had the Institute of Electrical and Electronics Engineering study. We'd be pleased to share it with you. We had the "Alliance" of six aerospace companies that wrote a 650-page report pointing out all kinds of things that could go on in space if we could get the costs down. And within the last month, the Space Transportation Association and NASA has reached a Space Act agreement to look at what the country needs to do to start a major space tourism business. This followed on Japanese studies, of which I'm personally quite familiar, saying that there's a $10 billion a year business there at least.

I have no question in my mind but what, if we get the unit costs down, business will burgeon. I grew up in the satellite communications business and was pleased to see how things worked out.

Now, as to your second question—Mr. Chairman, I love everybody, so I don't want to be misunderstood in what I have to say. I don't like the word "culture." I use it in other respects.

We have in NASA today a simple lack of understanding and of experience of what is required to attack such a fundamentally different problem than they ever had before. And the same is true for the major space industries. They are smart, responsible, highly educated, experienced, and successful people.

We're telling now the football team, though, "We're going to play hockey." And it is a very difficult and vexing thing to do. There is no way, by diddling and extrapolating what's now called procurement practices, that we're going to get at the throat of this 1,000 to 100,000 LEO-surface cost difference.

At one time I was the director of research at the Department of Housing and Urban Development. There was a very large public housing program in the Midwest. It had won all sorts of architectural awards. In the succeeding 10 years for the people who resided there it had turned into Hell. There were all kinds of studies made about how we can modify this and modify that and modify something else.

Secretary Bob Weaver asked me to go out and spend some time, come back and give him a suggestion. I brought some of the smartest people I knew out there. We came back and we said, "Dynamite it."

It's impossible to say that it's impossible. If what we want—(by the way, other housing was found for the people and it was dynamited.) Now, that's what we're talking about. If you're serious in the civil space area, if we want the business to burgeon in the manned space area on which we have spent hundreds of billions of dollars, we've got to get costs down and we can't do it by diddling with it.

Mr. DOYLE. I guess my time's up.

The CHAIRMAN. The time of the gentleman has expired.

Mr. DOYLE. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Weldon.

Mr. WELDON. I'll thank the chairman.

I'd like to direct some questions to Mr. Muratore.

I had the opportunity to visit Johnson Space Center and I was very impressed with the report that I received about how the new Mission Control Center was set up and just the fact that there was a tremendous amount of savings being appreciated by the taxpayer and I want to congratulate you for that.

There is an article in Rolling Stone—are you familiar with that article?

Mr. MURATORE. Yes.

Mr. WELDON. I haven't read the whole thing but as I understand it, there were some obstacles you encountered along the way trying to do what you were trying to accomplish. Is that correct?

Mr. MURATORE. Yes, sir.

Mr. WELDON. Could you elaborate a little bit on that in terms——

Mr. MURATORE. Actually, I appreciate the opportunity to tell you about it.

The Rolling Stone article was written for good copy to be read. I mean, it was to be enjoyed and be read. It was not intended to be a detailed report of what happened and I believe there was some misinterpretation of that.

NASA consists of a lot of people who truly care very deeply about what they do. And the problem is now we've got a bunch of people who truly care very deeply about what they do and they have a certain way of doing business, and an expensive way of doing business. The trick is to try to get those people who care deeply about what they do out of the rut of the way they're working and into another way of doing business that is more cost effective. That's particularly difficult because, as Ms. Lee pointed out here, we have this issue of accountability.

Two and a half years ago as we started on the path to the Control Center I wasn't sure if I was going to be sitting here talking to you about how well this worked out or sitting here explaining to you why we did all these crazy things and took some chances with the way we were building the new Control Center.

I mean, there was a lot of reluctance on people's parts to just start a new way of doing business given that the past way had been successful and we were dealing with such a critical resource

and facility. So there were some natural disagreements between people about the way to go that had to be worked out in the fullness of time.

I think the senior management at Johnson Space Center deserves a lot of credit because they let that kind of dialectic go on for a while. There was a lot of very heated disagreement, as there will be in a roomful of engineers when we're talking about how to solve a technical problem.

Then the management at the Johnson Space Center made a very courageous decision. They said, "We're going to try this crazy new approach because we don't see how we can afford the old approach." That's when we started with what we call "the pirate revolution." The idea of challenging the way we've done business; how we scrubbed out all of the paperwork; how we got to an approach where actually NASA was, I think, in better control of what's going on, making the critical systems engineering decisions. But we got ourselves out of the detailed decisions on how to implement the problems.

So I think the article is a lot of fun to read. And I think the real important point here is that there is a big cultural change that has to take place and that people have to have the courage to go ahead and try that.

Mr. WELDON. Is there anything you would do differently having gone through that and been successful? Could you do it even better?

Mr. MURATORE. I think the challenge is in expanding this sort of an approach.

Mr. WELDON. That was my next question to you. Can we take the example of what you did and apply it to other programs?

Mr. MURATORE. I think you all provided a challenge to NASA. I think down in the field centers we hear it pretty clearly that we have to change the ways we're doing business if we expect to implement the kind of dreams that we have. Because NASA is about a dreams business.

I hear a lot of talking about it being about a business and we do want to contribute significantly to the economic competitiveness and capabilities of the nation, and we should. But for the people attempting to implement what they dream the future could be, of people living and working in space, I think the thing to do is to keep the challenge on us. It's very tough. Don't look at the way we've done it in the past. The past is not necessarily a solution. We've got to challenge that.

I think the most interesting thing that came up out of the article to me was that the article sort of implied that physical age was the discriminator. And physical age isn't the discriminator. The discriminator is this sort of your mental age about how you want to attack the problems.

I think there are plenty of people in the agency throughout the age range who are ready to find new ways of doing business. I think if you just keep challenging us we'll find a way.

Mr. WELDON. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Mr. Olver.

Mr. OLVER. Thank you, Mr. Chairman.

I guess I will go back and delve into what my colleague from Pennsylvania had been talking about a little bit because he was on the edge of something that was puzzling me.

I also have not heard all of the testimony but in Mr. Frelk's testimony I was struck by the particular statement which I have here:

"One of the major impediments to achieving innovative partnerships between NASA and industry pertains to the data rights issues that I alluded to above. The normal presumption under NASA contracts is to make all data generated under the contract available to all at the marginal cost of reproduction. This "open door" policy is anathema in the commercial world where the value of data is defined by the willingness of the marketplace to pay for it."

That raises a number of specters in my mind.

Mr. Rogers has then pointed out that stuff in relation to space travel and things that we might gain from the space station's research and the space station's development are now three to five orders of magnitude more expensive than travel on Earth. And it's hard for me to see how one is likely to be able to reduce those by more than one to three orders of magnitude. It still leaves them in very large divergence from travel close by. And I'm thinking to myself I don't know whether these two things are supposed to interconnect in some way.

It seems to me where something is so expensive and is likely to be so expensive in the early stages that it has to be an agency like NASA functioning. I'm sure it can function better. But then Mr. Frelk has said it is an impediment, I think, unless I'm misunderstanding here, that the material that they find is then available to all. Why isn't that very expensive material that is available to all then the jumping off point from which all the other things come? I have a hard time believing that if we had not had a major agency like—well, the U.S. Defense or AEC, that did the Manhattan Project, that we would have done the Manhattan Project out of purely private industry because somehow the proprietary rights would be in a capacity for them to function with. Then all that material came out and led to such a huge number of advances in the early days of the space station. I have a hard time believing those would have happened if they had been left to a closed door policy, which is obviously not an anathema in the commercial world and so on, to rephrase the statement that Mr. Frelk has made.

I, as a scientist, believe that the mountains of data that have come out of our scientific work and having that available for all to use—the basic scientific work is extremely valuable and has been a major driver of all the other commercial things that have come out of it without prejudice to what might have been done there.

I guess I'm asking you to edify me please, between the two of you somehow on these connections.

Mr. FRELK. First of all, remote sensing—especially space remote sensing is derived from government's good work in the remote sensing area. We are now at a point where the technology is mature enough where companies like ourselves can simply proceed forward and do something commercially.

We do plan on providing our imagery images of the Earth to everybody. That's a given. But we're doing it in a free market sense where the marketplace determines the price.

If I sell that image to NASA or if I work with NASA on a project even with my infrastructure I may be required under that contract to give up the data rights to that imagery. So our model is somewhat like software. We're going to be licensing the imagery for use. Again, we have to deal with NASA on that basis to a certain extent.

What does NASA get in return? They don't have to spend the capitalization costs of putting up their own system. What they get is the benefit from commercial entities and investors literally paying for the infrastructure being put in place and the marketplace in itself buying images and creating industry. That, in fact, can feed back and reduce overall costs in the long run to NASA and how to go about getting the scientific information that they may need for scientific purposes.

So I guess what I'm saying is there is a proper role for NASA and the government in the groundbreaking areas. At a certain point where it's possible for a commercial entity to proceed forward on its own there's a possibility for significant cost savings to the government from commercial going forward. However, there are certain commercial practices such as data rights that are also important in sustaining a business in the future.

One of the things that was changed, frankly, by the committee on a bipartisan basis and allowed us to go forward was simply to say that when the private sector puts up a satellite themselves they're not subject to the same government regulation that says that you have to provide imagery to everyone at the marginal cost of reproduction. That's a real concern to the remote sensing industry.

Mr. OLVER. How does that relate to the space station? Maybe I and my colleague from Pennsylvania—I don't know whether we're really close enough here to indicate whether we're in the same ballpark or not but it seems to me you comment about there is a certain point beyond which—maybe we're talking about the orders of magnitude levels in this process of research in very large projects. To a point where one can expect that the commercialization can go on without the infrastructure commitment by the government. That is certainly a part of the space station.

He had asked a question, which I don't think was ever really answered, whether there was an indication that private industry would put up the space station by themselves if there was not a major commitment of monies in the first place, which I suppose, Mr. Rogers, you believe is contributing to the three to five orders of magnitude of cost difference. But I don't know if I've ever seen anyone suggest that those might be changed by, as I put it, more than one to three orders of magnitude, which is still an enormous difference.

The CHAIRMAN. The time of the gentleman has expired. But, Mr. Rogers, you may respond.

Mr. OLVER. My time always expires.

Mr. ROGERS. Ten years ago there started a series of studies. The first was the National Commission on Space under Tom Paine, another one by Sally Ride and one by Tom Stafford, all talking about going back to the Moon and on to Mars. They were all priced out at roughly $500 billion.

President Bush, on the 20th anniversary of the Moon landing, went to the American public and asked for their approval to pursue these programs. The American public said no, the Congress said no and that was the end of it.

For the first time in the civil space program, to my knowledge, the scientists and the technologists and businessmen were told "no," not on the basis of the substance but things cost too much. Today we're talking about doing that for something like $5 billion

Mr. OLVER. Two orders of magnitude.

Mr. ROGERS. Nobody's really cared about reducing costs. The Federal civil space program was put together under a national security context. The Soviet Union was driving us. When the bodies are piling up on the beach like cord wood you don't call an accountant.

Mr. OLVER. Can you tell me again what it is exactly that has changed from $500 million to $5 billion?

Mr. ROGERS. Going back to the Moon and going on to Mars with people. There are now people—very smart people in the space industry are talking about doing that for $5 billion. We have had hearings last week on the X33 program. That vehicle, with a large enough market, even with just a government market, should be able to get costs down by order of magnitude, and with a large enough market by two orders of magnitude.

And the studies done by the Alliance, the commercial space transportation study, suggests that if you get the costs down by something like a factor of 10 or a factor of 20 you start to get into the elastic domain. You start to see—you change the economic picture.

Now, it is not a question, sir, of basic research or technology. It is a mind set that says we've got to reduce the costs by orders of magnitude and then you start thinking about things in an entirely different way. It can be done.

The CHAIRMAN. Ms. Cubin.

Ms. CUBIN. Thank you, Mr. Chairman. I don't have any questions at this time.

The CHAIRMAN. Thank you very much.

I want to try and clarify several things here for the purpose of getting the hearing record clear.

First of all, I'm interested in the statement that you made, Ms. Lee, about the high risk of space. This was in response to a question. It seems to me one of the issues that is behind what we're saying here today is the fact, it is the knowledge that space is a very, very high risk business. Whether we're talking business side, the scientific side and so on we're always talking about very high risks.

The way NASA for some period of time now has chosen to manage that risk is to essentially take as risk averse an approach as possible.

You know, history does show us that risk is manageable if the profits are large enough. What we have tended to do is say, "No, we will do something to mitigate profit." We have then taken an approach that says, "Okay. If we're going to have a limited amount of profit on it we will also then try to mitigate your risk." And the

balance between those two, I think, is where we've created some conflict at the present time.

Now, we're either going to have to decide that we take the approach of remaining risk averse in some of these things or we are going to have to figure out a way to achieve greater profitability so when investors say, "Yeah, there's a huge risk involved but I'm going to get some money out with the idea of getting very, very big pay offs."

When some of my forefathers from Pennsylvania took off and went West looking for either land or gold—I mean, there were huge risks involved in the 19th Century in doing that as well. And most of them didn't get the huge pay off that they were hoping to get out of it but they thought there was a possibility. Somehow we have got to get the situation here that suggests there is a possibility of that.

Now, that brings me to what Mr. Dunn was talking about in terms of the ability under NASA's organic act to take an innovative approach. How many times in the last couple of years has NASA used the other transactions authority that you have under the law?

Ms. LEE. Mr. Chairman, I don't have a specific number for you but I can get it for you. Each center does some at the center level and then we do quite a few at the headquarters level. But I can certainly get that to you.

The CHAIRMAN. That would be helpful.

What strikes me about that is that it is something that would allow us to get by a number of the things you mentioned in your testimony. I think your testimony was helpful in having us understand the dilemma that you face in dealing with us. And I've got to say, in looking down through there, most of those dilemmas have been created right here on Capitol Hill.

Because you had a very impressive list of all of the things that you have to get clearances on in order to get a signed contract, and I understand that. But I think that what we are also looking at is ways in which we can find a lot more innovation and maybe the "other transactions" approach more creatively used might give us an opportunity to do that.

Now, Mr. Dunn, if I am correct, what this does involve though, is a need for some fairly creative and yet common sense type of negotiators. Is that not correct?

Mr. DUNN. To not beat a dead horse, the overused word "culture", absolutely it does. In September's issue of Government Executive Lisa Corbin wrote an article on the procurement system. The title of the article was "Culture of Fear."

The emphasis that I've seen in the procurement system is on getting everything right and the things you're getting right are complying with the rules and regulations and not on getting the goals right. Focusing on goals and accomplishments somehow takes second seat to crossing all the T's and dotting all the I's.

So the people that negotiate other transactions both have to integrate a big picture view of what we're doing and then also get the details right. But the details aren't driven by rules and regulations, they're goal oriented.

The CHAIRMAN. And the problem with all of that is, if I remember from someone's testimony—I've forgotten which of you said it.

Maybe it was Mr. Rossi who said after all of that, after going through all the hurdles and getting everything right with dealing with the agency the maximum amount of money that you can make out of this is about 12 percent. Which says to an investor, you know, if I have a choice between putting my money at risk at 12 percent or getting a fairly easy return over a period of years at 17 percent I'm not likely to want to clear all those hurdles and do all of that.

Is that what some of you in the business community are saying is a real problem in dealing in the world that you're now dealing in? The answer, just to make note, is yes, that's exactly where the problem lies.

In the "other transactions" approach, if I understand it, it's not a question of profitability but in the end in the "other transactions" one of the reasons for going ahead and taking the risk and doing the job is not only does government get the advantage of the technology but so does the business. Is that correct?

Mr. DUNN. If the business doesn't get the advantage of it, it doesn't work.

The CHAIRMAN. So in other words, by going that route for some procurement the business may not get any more than they would get in a regular contract with the government. But in the end they have gotten something of value that they can then take commercially and perhaps make more money with.

Mr. DUNN. First of all, they typically get less than they would get in the procurement because it's cost shared in almost every instance.

The CHAIRMAN. So they actually have to put money up?

Mr. DUNN. That's correct. But there are no restrictions on the ultimate return on investment of the product they develop. The product or process that they develop.

The CHAIRMAN. Mr. Muratore, as I remember, one of the advantages that would be found in what you ended up doing at Johnson, if I remember the conversation we had when we were down there, was you not only then took an innovative approach in terms of bringing this in at lower cost than had been done before but now business discovered that the integrated system that you developed is, in fact, something of value to them, that they're spinning back out into the commercial sector. Is that right?

Mr. MURATORE. Yes, sir. That's correct. A lot of the things that we learned are already implemented in products that are out there in the field.

The CHAIRMAN. So what you were able to do is take technology out of the marketplace, integrate it in ways different than business had done it before and then business finds in that innovation something they can then take back out in the marketplace that then gives them some profitability for having worked with you. Is that correct?

Mr. MURATORE. That's absolutely correct.

The CHAIRMAN. It seems to me that what we're looking at here is not necessarily something which is aimed at substituting a business approach for a NASA approach or a NASA approach for a business approach. But ultimately what we're looking at here is the

kind of cooperative programs that give everybody something of value and hopefully give the investor some kind of return.

I guess what I'm puzzled by is if that's so clear why can't we get there?

Mr. FRELK. I think there's a little bit of a misunderstanding also.

I was listening to Ms. Lee's comment that she was describing commercial in terms of a personal acquisition and NASA in terms of a government acquisition procurement and I think the analogy is wrong.

As an officer of a commercial company, when I go out and procure something I'm accountable to the board. The harsh consequences of inappropriate action and accountability procuring things means that we go out of business. Our investors lose their money. I lose my job. There's a great deal of accountability amongst commercial entities and how they go about doing business. And in some ways I think they're much more flexible than the way government is currently allowed to conduct a procurement.

Between NASA and industry we can take advantage of the best of both worlds. Not only NASA's ability to develop technology and do the cutting edge technology but also take advantage of the private sector's ability to get a economies of scales because of these market pressures and keeping costs down and operating based upon market forces.

So I think the analogy that you came up with is a little bit wrong. When I go out and procure something for my company I'm not acting as an individual going out and buying a super 8 tape. I do have a great deal of accountability and there are practices that the commercial industry does follow quite closely that are quite strict.

The bottom line is we have to be profitable. If we lose money we go out of business. If NASA loses money in how they procure something they don't go out of business.

The CHAIRMAN. But as Ms. Lee says, she probably finds a very hostile audience at this committee. I mean, in other words, you have a hostile audience at your next board meeting if you lose some money. She also ends up with a very hostile group of Congressmen who are asking how in the world did we come up with this.

And, you know, in defense of that, we've created some of that situation because the other answer to the question we will say is, "Why didn't you dot every I? Why didn't you dot every T? Why is it that this particular procurement, this section of the procurement act wasn't agreed to?" And we'll have some people who will spend hours trying to find out whether or not there wasn't some line of some procurement act that was violated that resulted in this kind of loss. That really is a frustration, I know, from some people who are trying to bring about some reforms down there. It's a frustration for me here on Capitol Hill.

Go ahead, and I think Mr. Burnett also wants to speak.

Mr. FRELK. Mr. Chairman, I know that this Congress is trying to act more like a business. What I will tell you is that businesses can act in the same way when they focus more on process as a board than the end result. Once they do that and develop large bureaucracies they tend to go out of business or be very unsuccessful. So there's a market correction that takes place.

I guess what I'm hearing from you is that there may be a market correction taking place even in Congress in how they approach as maybe the board of directors and how we're doing these things, which is positive from our perspective.

The CHAIRMAN. I hope so.

Mr. Burnett.

Mr. BURNETT. You asked the question as to why we seem to have a win/win situation but we can't seem to implement it. To me it seems that perhaps the system doesn't reward the people in the government to take the risks that are necessary to enter into these kinds of agreements or to foster them.

I think more can be done both at the agency level and by Congress to help incentivize the employees and the managers to foster commercial development of space and to take the risks that are inherent in these kinds of arrangements.

The CHAIRMAN. Do you happen to know if the arrangement that was made with John Cassanto was, in fact, under the "other transactions" section of the code?

Mr. BURNETT. I do not know if it was specifically referred to there or not, but it certainly would fit under that. I think there's a lot of places that you could find authority for that kind of agreement. NASA has a tremendous amount of authority under their act.

The CHAIRMAN. Do we end up with any kind of intellectual property problems as we do other transactions? I mean, have you run into that, Mr. Dunn. Or do you know of any of that kind of thing, Ms. Lee?

Mr. DUNN. Intellectual property is the heart of research and development and innovation. There are many potential problems in the government system as it exists, and you've already heard some of them.

One of the things that we do with other transactions is we're not one of those instruments, contracts, grants or cooperative agreements that are regulated by the government-wide law allocating patent rights. And as a result of that rather than having only a "one size fits all" solution we have flexibility.

I gave you the example of Cray Research. We could not have entered into an agreement with Cray Research and used a standard patent clause. They don't do business that way. They don't patent their inventions. They keep them as trade secrets. We just couldn't have done business.

For government contractors we've created them in our image and they know how to do business with us. If we want to expand our scope elsewhere we have to be prepared to be flexible and goal oriented in our approach to intellectual property.

The CHAIRMAN. Ms. Lee, would you like to respond as well? And then I want to follow up on just exactly that point.

Ms. LEE. I have to agree that it is the heart of many, many issues. And when we're asking industry, particularly when we're asking to cost share their long term gain in that investment in their corporate R&D, to be able to use in some sort of an exclusive basis the results of that research then we find ourselves in that conflict of well, the government contributed or the taxpayer's contributed

X-numbers of dollars as did corporate. Who owns the rights? How should they be used? That's a constant struggle.

We're trying to address that on each and every activity, particularly with our cooperative agreements for industry. We have a more unique approach and a more generous approach than the traditional contract format.

The CHAIRMAN. Here's what really floors me. There was an analysis by a management consultant, Robert Spring, in last year's Business Week scorecard. It indicated that 95 percent of the industry group leaders in that scorecard received insignificant or no awards from DOD, which seems to indicate that 95 percent of the cutting edge technology firms in the country are not doing business with the federal government. In fact, what he said was that he concluded that a significant share of the most valuable research and product development in commercial firms is virtually unavailable to the federal government.

Now, first of all, I guess I'd ask whether or not that's a conclusion that you would agree with, Mr. Dunn.

Mr. DUNN. That's exactly the problem that we're attempting to solve with other transactions. Hewlett-Packard, Intel—we've been able to do business with all of them.

The CHAIRMAN. Precisely. My concern is if that's the case at DOD my guess is it's also true at NASA, it's true other places. That by the time they look at the hurdles they have to jump and all the questions that I've raised here previously, it means that there is actually a disconnect between a lot of what's going on in high tech and what's going on in the government, which in an area like NASA where we're trying to bring down the cost of going into orbit and all of these things, it's a disaster.

And I think part of what we're trying to get in this hearing is how we can, in fact, lower the hurdles in whatever cases we can eliminate the hurdles and find ways that we can now share in all of that technology development that's going on so that we can begin to get to some of Tom Rogers' dreams of how you get people involved in everything from tourism to—I like to think of not only space stations as a commercial park or as a town but as a commercial center, a commercial business center, if you will. So there are opportunities that it seems to me we're missing.

Ms. Lee, you wanted to respond.

Ms. LEE. I just wanted to reiterate what Mr. Dunn had said earlier. I think we really urgently need to make a change in our thought process. He's right, we particularly in the specific procurement community have gotten ourselves into the thought process. Our goal was to write this perfect contract. That's not our goal at all. Our goal is to support the mission, to accomplish whatever research, to do whatever end product we need. To just do the paperwork and fill the squares is the wrong approach. So we are really aggressively in our community trying to say what is it we want to accomplish? We can get there and we have to use these different tools and we must take some risks.

The CHAIRMAN. And I believe you really are trying.

I think one of the things that Dan Goldin has done is changed the direction at NASA toward that kind of thing.

But I've got to tell you, to build off of something that Mr. Olver said here a couple of minutes ago, you know, what is it where commercial firms have indicated an interest in doing anything like space stations and so on. Well, in fact, they did. It was called CDSF a while back. One of the reasons why it didn't get done is because NASA discouraged it from being done. NASA saw it as competitive with what they were attempting to do on space stations, were afraid it would get in the way of doing the space station and so therefore were very reluctant to see something like that go forward.

The fact is, as a country we might have been able to do both. And at some point we need to understand that people in the commercial sector who come up with ideas that have merit and can be done at reasonable cost need to be encouraged, not discouraged, from pursuing those.

Mr. Rogers.

Mr. ROGERS. I would say this is why, Mr. Chairman, I advanced a notion, not particularly original with me, of using the Space Station as a kind of institutional and financial "bank." The wonderful thing about the Congress (if it becomes law) saying, "The space station shall be commercialized," you're starting with a blank sheet. You're starting from zero. And the challenge of that, to use that "bank" should be put onto NASA and the space industry and anybody else: We're now going to go all the way back to zero, all the way back to bare wood and this time the Space Station program is going to do, whatever else it does, assist directly in getting these costs down and getting privatization started and getting commercialization started. I think that's the beauty. You're starting afresh. Thank you.

The CHAIRMAN. Just one final question along that regard.

Ms. Lee, is NASA, in your opinion, ready to take a market approach to station operations?

Ms. LEE. In my opinion we're getting there. Are we ready right now today? No. Are we going to get there? Yes. Our administrator has highlighted some of these points. I've heard him so many times echo Mr. Rogers, "We've got to get the cost of transportation down. We've got to get industry more involved. We've got to make space more accessible. And NASA has got to get back to our core mission versus an operations activity."

Are we ready today? No. Will we be there? Yes.

The CHAIRMAN. Good.

We're about to finish up here. I want to acknowledge that Mr. Ward has joined us. Do you have any questions?

[No response.]

The CHAIRMAN. I thank you all. I timed that perfectly, just as the bells go off. Thank you very much. It's been a very helpful hearing. Thank you.

Could I get an agreement from each of the witnesses to answer some questions in writing? Thank you.

[Whereupon, at 1:15 p.m., the hearing in the above-entitled matter was adjourned.]

[The following material was received for the record:]

Mr. Walker submitted the following questions for Ms. Deidre Lee to NASA on November 17, 1995 with the request that they be answered by November 30, 1995. The House Science Committee did not receive any reply by the date of publication of this hearing (March 18, 1996).

1. Your testimony suggests that NASA is aware it has a problem in working with the private sector and that it is working to fix the problem. Could you provide any more specific details about steps that NASA is taking or plans to take to improve its procurement practices and to find non-procurement methods of working with the commercial space sector?

2. What means does NASA use to assess the potential harm that NASA initiatives may do to the Nation's interest in promoting space commercialization and what means does NASA employ to prevent this result?

3. Does NASA have a data/intellectual property policy that will encourage space commercialization? If not, when will NASA have such a policy? Do you require changes in the procurement rules or legislation in order to protect private sector interests in making such capabilities commercially available?

4. The White House policy on commercial remote sensing prohibits government competition with the private sector in providing data and information services, yet NASA plans to make Mission to Planet Earth data and algorithms widely available to commercial customers at no charge. In effect, Mission to Planet Earth will subsidize such customers and undermine the private sector's ability to expand our space industrial base at no cost to the government. How do you think this would impact the private development of space infrastructure and earth observing capabilities? If that reduces private sector investment in new earth observing technology and the space industrial base shrinks, won't that make contractors more dependent on government appropriations and increase NASA's costs in the long run?

5. Mr. Muratore offered some excellent testimony demonstrating that NASA can work constructively with the private sector and companies that do not define profit in terms of winning government contracts. Why is this the exception rather than the rule? When do you think it will become commonplace?

6. What can we do to help you achieve your goals?

7. How many funded and unfunded Space Act Agreements has NASA entered into? (Please provide a list of these agreements.)

8. You mentioned in your testimony that there had only been two successful protests against the agency recently. During the past five years, how many times has NASA canceled a procurement after a protest was filed?

9. How much authority to enter into "other transactions" under the Space Act does NASA headquarters give program managers in the field? To what degree is this authority limited to the NASA Office of General Counsel? Are there any obstacles that NASA headquarters has established to limit the ability of program managers and directors to enter into "other transactions?" How can Congress encourage NASA to use this authority more creatively and frequently?

10. Do you think increasing the Office of Procurement's authority to enter into "other transactions" to promote commercial space development would improve your office's ability to work with the commercial space sector?

11. Early in its history, NASA was exempt from many of the additional requirements that Congress and the President place on government procurements. Over the years, NASA has lost these exemptions and is now treated as a standard bureaucracy when it comes to purchasing goods and services from the private sector. How does this affect its ability to fulfill its role as a research and development agency?

12. Congress, the White House, and NASA agree that the agency can and should improve its ability to do advanced research and development that contribute to the Nation's economic well being. Besides streamlining procurement practices, pursuing more cooperative agreements with industry, and improving spin-offs, what mechanisms and models is NASA considering to make itself more effective at promoting space commercialization and improving economic performance? Could ARPA serve as a model for NASA, either in part or in its entirety?

QUESTION FOR THE RECORD
HOUSE SCIENCE COMMITTEE
NASA PROCUREMENT IN THE EARTH-SPACE ECONOMY
NOVEMBER 8, 1995

QUESTION NUMBER 1

NASA AND NON-PROCUREMENT AUTHORITY

Rep. Walker: Under the 1958 Space Act, NASA has the authority to engage in non-procurement "other transactions" to acquire capabilities for the United States. How does NASA use this authority and how does that compare with ARPA's use of similar authority?

Mr. Dunn: In 1993, this Committee (then named the Committee on Science, Space and Technology) noted in a report that, "In 1958, Congress gave NASA broad authority to enter into agreements with any party separate from those established by other statutes such as contracts, grants or cooperative agreements. To date NASA has used this authority largely to create unfunded instruments such as Memoranda of Understanding, Technical Exchange Agreements, and Joint Endeavor Agreements." (House Report 103-123, June 10, 1993). The same report stated: "NASA should create a funded Space Act Agreement . . . the Committee recommends NASA use a funded Space Act agreement especially when considering funding options for eligible participants that are not a part of the traditional Federal contracting base."

I would defer to NASA to whether it has created such an instrument and, if so, whether it has been used in other than rare instances.

The Advanced Research Projects Agency's (ARPA) use of "other transactions" include both funded and unfunded agreements but the vast majority are funded. ARPA's "other transactions," which are the equivalent of a funded Space Act Agreement, are fully integrated into ARPA's research and development efforts. ARPA seeks to attract research and development proposals from as broad a spectrum of the technology base as possible, not just from traditional government contractors. Therefore, ARPA is prepared to negotiate flexible arrangements in many research and development relationships and does not assume that the legal authority to enter into flexible arrangements will be needed only on an exceptional basis. Most research and development agencies are engaged in a broad range of activities which can

appropriately be characterized as primarily involving activities other than purchasing goods and services. These activities include advancing the state of the art, establishing industrial capabilities, establishing standards, transferring technology and encouraging scientific and technological cooperation, and similar activities. When engaging in such activities, numerous opportunities for use of nonprocurement agreements such as Space Act Agreements or ARPA's "other transactions" are available. Understanding that these opportunities are available is a key to using available legislative flexibility.

QUESTION FOR THE RECORD
HOUSE SCIENCE COMMITTEE
NASA PROCUREMENT IN THE EARTH-SPACE ECONOMY
NOVEMBER 8, 1995

QUESTION NUMBER 2

NASA USING LEGISLATIVE AUTHORITY

Rep. Walker: After examining your testimony, it appears that NASA has all the legislative authority it needs to copy ARPA's successful practices in working with the private sector for advanced technology research and development. Do you have any suggestions about how Congress and the President might help NASA make better use of this authority?

Mr. Dunn: The Advanced Research Projects Agency's (ARPA) cost-shared, dual-use, multi-party "other transactions" as well as other funded and unfunded "other transactions" rely on legal authority similar to that available to NASA under the Space Act. Congress encouraged ARPA to use this authority by authorizing $50 million in fiscal year 1991 for the conduct of dual-use consortia under the authority of 10 U.S.C. 2371. In fiscal year 1992 Congress authorized $60 million for a similar program. After conducting these programs, ARPA senior management, program managers and contracting officials were all enthusiastic about doing business in the new way.

On the question of legal authority, there is an area where Congress could provide additional authority in the area of 100 percent government-funded systems development. Congress has provided ARPA authority to conduct military systems prototype projects outside the procurement system (section 845, Public Law 103-160). Substantially similar authority is available more broadly to DoD components in specific technology areas including aeronautics (10 U.S.C. 2373). To date, only ARPA has used this authority. Similar authority could be useful to NASA in developing prototypes of new space or aeronautical systems.

QUESTION FOR THE RECORD
HOUSE SCIENCE COMMITTEE
NASA PROCUREMENT IN THE EARTH-SPACE ECONOMY
NOVEMBER 8, 1995

QUESTION NUMBER 3

ARPA'S UNIQUENESS

Rep. Walker: Is there anything unique to ARPA's organization or formal structure that improves its ability to work creatively with the private sector?

Mr. Dunn: The Advanced Research Projects Agency's (ARPA) charter authorizes it to engage in revolutionary or high pay-off projects. High pay-off typically means high risks. ARPA has long been risk tolerant, and it is this risk tolerant culture that has given its contracting and legal staff the freedom to innovate and experiment in searching for better ways of doing things in the contracting arena.

ARPA was created in 1958. A report prepared for this Committee has noted, "in a genuine sense, the first U.S. space agency was . . . ARPA." (United States Civilian Space Programs 1958-1978, p. 46, Report for Committee on Science and Technology, Congressional Research Service, 1981). Both as a space agency and later as a technology agency with a broader charter, ARPA has resisted the temptation to create a large infrastructure of government or contractor operated laboratories, research centers, and other facilities. ARPA has always remained small in number of personnel assigned. Talented program managers and adequately funded programs are a key to ARPA's success. ARPA has a simple, flat organization. Program managers exercise considerable discretion and have access to the Director of ARPA. New ideas are welcome and changes of priorities and program direction can be managed expeditiously. The lack of infrastructure noted above means ARPA can drop less productive programs and reorient priorities to more productive areas.

The net result is that ARPA can be highly responsive to good ideas found in the industrial and academic communities as well as respond to new priorities developed by national or departmental leaders.

QUESTION FOR THE RECORD
HOUSE SCIENCE COMMITTEE
NASA PROCUREMENT IN THE EARTH-SPACE ECONOMY
NOVEMBER 8, 1995

QUESTION NUMBER 4

ARPA AS A MODEL

Rep. Walker: ARPA's successes in promoting creative innovations in advanced technology are well known. Do you think ARPA could serve as a useful model for reorganizing all or parts of NASA? What characteristics of the ARPA model might limit its application to NASA?

Mr. Dunn: The Advanced Research Projects Agency's (ARPA) success suggests that some government agencies with research and development missions should consider chartering a high-level entity with responsibilities that cut across organizational barriers, or functional areas and which seeks revolutionary rather than evolutionary solutions to current or future problems. Such an organization needs to be adequately funded, unburdened by infrastructure, small, nonbureaucratic and chartered to operate through existing organizational structures or independently.

The ARPA model is probably not well suited to an organization that sees its mission as primarily maintaining existing government infrastructure and capabilities or maintaining support for academic and industrial research in selected disciplines.

ARPA is part of the Department of Defense (DoD), which, like NASA, maintains an infrastructure of laboratories and facilities. ARPA takes advantage of the personnel and facilities of other DoD components in carrying out its mission. ARPA probably could not serve as a model for all of NASA. Whether it could be a model for part of NASA is a matter for NASA to determine.

QUESTION FOR THE RECORD
HOUSE SCIENCE COMMITTEE
NASA PROCUREMENT IN THE EARTH-SPACE ECONOMY
NOVEMBER 8, 1995

QUESTION NUMBER 5

COOPERATIVE AGREEMENTS

Rep. Walker: The Congress and President have promoted cooperative technology development between government and the private sector. NASA's implementation of these policies has been limited to Cooperative Agreements, in which NASA pays private corporations to develop new technology and private companies commit their own additional funds to the project. How widely does ARPA apply this approach? How does ARPA's implementation of Cooperative Agreements differ from NASA's? How does this type of arrangement compare with "other transactions" arrangements?

Mr. Dunn: The Advanced Research Projects Agency (ARPA) seldom awards cooperative agreements. Unfortunately, cooperative agreements have a tradition of lore and regulations going beyond what is actually required by law. Most agencies that award cooperative agreements to commercial firms impose government audit, accounting, and cost standards although not required by law or government-wide regulations. These are anathema to commercial firms. These and other inflexible government policies and clauses are familiar and comforting to government personnel but confusing and unnecessary in the eyes of potential commercial partners. ARPA's approach has been to use "other transactions" to signify a shift away from previous tradition and lore.

The ARPA approach under "other transactions" is to be as flexible as possible, defining project goals and reconciling them with maintaining the public trust on a case by case basis.

A key legal distinction between cooperative agreements and "other transactions" is the applicability of the Bayh-Dole Act (35 U.S.C. chapter 18). This law is applicable to cooperative agreements and greatly limits flexibility in the treatment of patentable inventions. Government contractors seldom object to the clause required by this statute. Its provisions are, however, often unacceptable to leading edge, commercial high-tech companies.

Experts can debate the merits and fairness of the Bayh-Dole Act's allocation of patent rights. The bottom-line is that any government-imposed standard which can be modified only by resort to a seldom-used bureaucratic waiver process will discourage nimble, high-technology commercial firms from doing business with the government. ARPA's experience has been that this is often an important issue. As an example, I would cite our research and development agreements with Cray Research, a leading supercomputer manufacturer. Cray has been a supplier of supercomputers to DoD, NASA, and other government agencies. Cray refuses to accept contracts and agreements which would subject it to a Bayh-Dole patent clause.

QUESTION FOR THE RECORD
HOUSE SCIENCE COMMITTEE
NASA PROCUREMENT IN THE EARTH-SPACE ECONOMY
NOVEMBER 8, 1995

QUESTION NUMBER 6

"OTHER TRANSACTIONS" GUIDELINES

Rep. Walker: What guidelines does ARPA use in determining the use of "other transactions" authority? When is it not appropriate to use "other transactions?"

Mr. Dunn: "Other transactions" are used to stimulate and support research and development for public purposes and activities such as advancing the state of the art, establishing industrial capabilities, establishing standards, transferring technology and encouraging collaboration. Under the specific statute applicable to the Advanced Research Projects Agency (ARPA), "other transactions" are used only when a standard procurement contract, grant or cooperative agreement is not feasible or appropriate (10 U.S.C. 2371).

A "standard" procurement contract is described in Part 16 of the Federal Acquisition Regulation and has as its principal purpose acquiring goods or services for the Federal Government. A "standard" grant or cooperative agreement (based on 1989 standards, the enactment date of 10 U.S.C. 2371) is used to provide assistance to a single university or non-profit research organization in the area of basic and applied research. Many research and development activities performed under cost-shared agreements with milestone payments with consortia or commercial firms are appropriate for "other transactions."

QUESTION FOR THE RECORD
HOUSE SCIENCE COMMITTEE
NASA PROCUREMENT IN THE EARTH-SPACE ECONOMY
NOVEMBER 8, 1995

QUESTION NUMBER 7

DEFENSE PROCUREMENT COST DRIVERS

Rep. Walker: Coopers and Lybrand and The Analytical Sciences Corporation recently studied DoD contracting procedures and found that, based on 10 key cost drivers, government procurement regulations and oversight resulted in an 18% cost premium on defense procurement contracts. If you are aware of this study, are there other cost drivers that would actually make the percentage greater? Other than engaging in "other transactions," does ARPA have any means or ability to escape these cost drivers?

Mr. Dunn: A considerable cost savings on an "other transaction" as typically negotiated by the Advanced Research Projects Agency (ARPA) with a consortium is believed to be derived from the avoidance of "burden" or administrative costs associated with a prime contractor transferring funds to a subcontractor to perform subcontracted work. In a typical "other transaction" there is no prime contractor and the organization distributing funds (often referred to as the "lead participant") acts as a conduit without adding burden or administrative expense. Even if the consortium subcontracts some work, any administration is done on a fee-for-service basis and not on a fully burdened basis.

Cost-sharing and participant self-interest is a key rationale for reducing or eliminating direct government oversight. The Coopers and Lybrand study did not consider reduction of government oversight in its cost analysis. Cost-sharing should also drive the participants to minimize their other costs such as material costs - a factor not considered in the study.

The financial cost and opportunity cost of requiring a government-certified subcontracting system was not considered. A government-certified system has proved to be slower for both routine and emergency procurements. Thus the government system can impact schedule which in turn affects cost. Furthermore,

government subcontract competition requirements inhibit the development of "strategic relationships" which are focused on quality and reliability as well as cost.

One company reported that the procedures of its government-certified purchasing system required four months to compete the procurement of 60 Pentium processors. By the time the government-required process with its accompanying paper work was complete, the market price for the processors had dropped to less than the negotiated price.

Other than engaging in "other transactions," a fundamental reform of the procurement system is necessary to eliminate many of the legal and regulatory cost drivers identified in the Coopers and Lybrand study.

Equally if not more profound than the specific cost penalties identified by Coopers and Lybrand are the lost opportunity costs which these government requirements cause. These include the potential benefits of commercial-government integration, access to leading edge technology, and expanded competition resulting from an integrated technology base.

November 8, 1995
House Science Committee Hearing
Questions from Chairman Walker
for
Jim Frelk
Vice President, Government Operations
EarthWatch, Inc.

(1) The government has already granted 9 operating licenses for privately-financed, designed, owned, and operated earth remote sensing satellites. Do you expect more companies to enter the market?

- Yes. We are aware of at least one venture that is seriously considering entering the market within the next two years. As a direct result of the predictable and stable policy environment created by the 1992 Land Remote Sensing Policy Act of 1992, we fully expect the commercial space imaging business to be generating over $500 million in gross sales by the end of the decade. When one adds in the value-added companies that will be created, we are convinced that a major new industry sector, with new markets and new sources of employment, will be generated.

(2) Have you discussed the potential for the private sector to help meet the data requirements of NASA's Mission to Planet Earth with anyone in NASA?

- EarthWatch's views on how the commercial sector can assist MTPE in more cost-effectively developing and distributing imaging data has been solicited by a special task force organized by the NASA Administrator to examine various options to restructure MTPE. In addition, EarthWatch has submitted an EOCAP (Earth Observation Commercial Applications Program) proposal to NASA's Stennis Space Center that proposes to develop a commercially-driven information systems architecture for archiving and disseminating imaging data to a diverse range of end users.

(3) Do you find that different portions of NASA have a better understanding of how to work with the commercial space sector in promoting national commercial and science goals in civil space?

- Although it appears that the agency as a whole is trying to rethink its overall approach to developing partnerships with the commercial sector, we have been particularly impressed with the efforts of the space remote sensing program office at Stennis.

Stennis seems keenly aware of the synergistic relationship between new commercial ventures and NASA Science programs, and has focused a great deal of effort in bringing the two together.

(4) Do you think EarthWatch and other companies might be willing to alter their spacecraft in order to improve the private sector's ability to provide scientists with the data they want if the government were to commit to direct purchases of data for research? Do you need that commitment upfront?

- As long as it did not hinder our ability to generate products for our commercial customers -- as well as not impeding our launch dates -- we would be pleased to enter into discussions with the government on how our spacecraft might be altered to meet scientific requirements. We would also want to be assured that intellectual property rights concerns were satisfactorily addressed. As to whether or not we would need the government to make such a commitment up front, it would depend on the nature of the requirements. In general, up front commitments, if possible, are important.

(5) What kind of model does EarthWatch use to address its requirements for data rights and intellectual property?

- The model that we have found to be most compatible with the nature of our marketplace and customer applications is the site licensing strategy successfully deployed by the software industry.

(6) As a company whose principal business market is not NASA, how do EarthWatch's requirements differ from those of a normal NASA contractor whose principal business is with the government?

- In contrast to a typical company contractor dependent for its viability on the agency procurement process, EarthWatch is a commercially-driven venture whose technology, market and customer base are completely independent of NASA. As a result, our requirements when doing business with the agency are based on a relationship of mutual benefit and equality. In that context, our requirements are straightforward. For example: We are open to scenarios in which, in return for NASA giving us access to a particular state-of-the-art technology at nominal cost, we would be open to exploring incorporating that technology into our system. In return, EarthWatch might offer the agency access to the resulting data based on nominal terms.

(7) Is NASA continuing investments in remote sensing technology and capabilities that have little potential for commercialization in the future or that compete with similar existing or planned investments by the private sector (i.e., is NASA duplicating any private sector functions?)? What technology investments should NASA be making now to pave the way for future growth in the commercial remote sensing industry?

- Some NASA sensors are designed to answer specific scientific questions and, by definition, have little commercial potential. Some NASA remote sensing payloads (Landsat, Clark, etc.) are very similar to planned commercial remote sensing investments. Consequently, some NASA imagery requirements, especially in the areas of land-cover assessment, elevation, and surface hydrology and geology could be met by the private sector.

  To stimulate growth in the remote sensing industry, NASA, in participation with industry, should invest in developing lower cost, higher performance technology, which in turn would lower risks for private sector investment. NASA's Lewis satellite is a good start. Another example would be a NASA-industry partnership in Synthetic Aperture Radar (SAR).

(8) Are non-NASA agents of government undertaking any activity detrimental to the development and growth of the commercial remote sensing industry?

- We continue to be concerned about the potential for competition from segments of the national security/intelligence community who from time to time indicate an interest in making available imagery at marginal cost. The future viability of our embryonic industry is dependent on investor and customer perception that the government is committed to a long term stable and predictable policy environment. It is critical that the Congress make clear its intent that the government not represent, directly or indirectly, a potential competitor to the private sector in the provision of space-based imagery data.

(9) Are foreign governments pursuing policies that undermine the development and growth of the commercial remote sensing industry?

- Foreign governments will continue to compete directly with commercial remote sensing ventures. Despite claims to the contrary, all the existing and planned <u>foreign</u> remote sensing <u>satellites</u> are <u>not</u> commercial. France (SPOT), Israel, Russia,

India, Japan, and Canada have and will launch remote sensing satellites that are labeled "commercial" but in fact are totally subsidized, from construction through product pricing. Essentially, foreign governments are selling government imagery "commercially".

Foreign governments will also look toward commercial ventures for clues regarding what types of satellites to launch and what markets to go after. And, with heavy subsidization, they will attempt to underprice the commercial competition. In this environment, several U.S. firms are attempting to sell similar products without any government funding for satellite manufacturing, launch or operation, without any price supports, or without any pre-launch data purchase commitments.

(10) Is the government effectively implementing its national policy on commercial remote sensing? What steps would you recommend that government take in order to improve its policy and/or implementation?

- As the prime lead agency for implementing the 1992 Land Remote Sensing Policy Act of 1992, the U.S. Department of Commerce has done an effective job of implementing its provisions. With that said, there continue to be ambiguities in the regulations implementing the legislation that require immediate resolution. For example, there is currently a limit on the amount of foreign equity that can be secured by an applicant (currently set at 25%). It is our view that, given the global nature of the imaging market, the threshold for equity needs to be increased to at least 40%. We believe that there are sufficient mechanisms in place to ensure that the entity remains U.S. owned and that the foreign policy and national security concerns of the government can be properly met.

(11) Could you explain the relationship between private financing of commercial remote sensing satellites and government funding of the space station?

- Private funding is available for remote sensing for all the reasons that make commercial funding for the Space Station in the near term highly unlikely -- pent up commercial and government demand for space-based imagery products and services has been demonstrated, the technology can be capitalized at a level supportable by the private investment community, and the return on investment horizon is within a reasonable time period (three to five years).

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THOMAS F. ROGERS

7404 COLSHIRE DRIVE
MCLEAN, VA. 22102

November 30, 1995

Robert S. Walker
Chairman
Committee on Science
Suite 2320 Rayburn House Office Building U.S. House of Representatives
Washington, D.C. 20515-6301

Bob —

This is in response to your letter to me dated November 17, 1995.

In it you asked for my response to questions it contained relative to your Committee hearing of November 8. 1995.

Enclosed are my answers.

Also enclosed is a related paper. I was prompted to write it as a consequence of thinking about these questions, and reflecting upon the testimony of the other hearing witnesses and conversations I have had with professional and business acquaintances since the hearing.

It strives to set out the basic Space Station "commercialization" issues. And it ends with a specific suggestion about how our Country could now use the Station and its ongoing operating program to hasten the day when the human spaceflight area could become one of large scale economic growth as is the space information area today.

Thank you for inviting me to testify.

I trust that this further response will be useful to you and your fellow Committee members.

Sincerely,

Tom

T. F. Rogers

Enclosures

ANSWERS TO THE QUESTIONS ASKED OF T.F. ROGERS

BY REPRESENTATIVE ROBERT S. WALKER,

CHAIRMAN OF THE HOUSE COMMITTEE ON SCIENCE,

IN HIS LETTER TO T.F.R. DATED NOVEMBER 17, 1995.

Submitted by T F.R. on November 30, 1995.

N.B. In all that follows please note that, unless otherwise specified, I am speaking about the Federally funded civil space program, especially the human space flight area including especially the Space Station program. I am not speaking about either the commercial-industrial information space area or the military space area.

The questions are searching and basic ones, and I have given the best answers that my experience and judgement allow. Nonetheless, I have found it difficult to come to grips, satisfactorally, with what I perceive to be a most difficult and vexing circumstance of great importance to our Country's future in space by answering these questions alone.

The United States must learn how to get the unit cost of basic space infrastructure down, sharply and soon, in the human spaceflight area so as to see large and early economic growth therein as there already is in such information areas as satellite communications. Only in this way can we expect to see large and early economic growth in this area and a much more sustainable publicly funded civil space program.

Therefore, I have also written a paper that draws specifically upon my own NASA-related business experience: upon the testimony given at the November 8, 1995, hearing: upon the questioner's concerns evident in the crafting of the questions: and upon discussions I have had with other space businessmen since the hearings.

The paper, entitled "...The Fullest Commercial Use Of Space", is attached.

Question 1. "...we've identified a significant limitation in NASA's ability to implement creative agreements to work with the private sector in promoting space commercialization and acquiring new capabilities at a lower cost. We've also heard at this hearing that NASA recognizes the problem and is working to address it. Would you please comment on whether this high-level attitude in NASA is reflected throughout the agency, especially where the rubber hits the road when it comes to working with the private sector?"

Answer: Over the past thirty-five years I have been in communications with NASA on a wide variety of topics and in various capacities. Over the past decade, essentially all of my business communications with NASA have been in the Space Station area, and they have all focussed upon trying to achieve sharp and early cost reductions therein.

Until a very few years ago, I found, again and again, that trying to do so was hopeless.

Recall that, in the 1980s/early 1990s, NASA and our space industry really expected that the American public would provide some $500 billion (!) to place a modest settlement on the Moon and send a few people to the surface of Mars. Toward the end of this interval, they still expected to obtain some $15 billion per year in public funds for a program whose central thrust was science, and further expected that this annual sum would increase at a 10% per year real growth rate.

In this climate trying to have NASA and our space industry focus upon cost reduction was simply not possible -- it was implicitly taken to be irrelevant.

Now this climate has clearly and markedly changed. Our nation's economic circumstances and our the Federal government's financial circumstances will no longer allow it.

In this context, then, the specific answer to your question is:

- o The NASA Administrator knows this and is trying to turn things around.
- o Several of the people that report directly to him are also working hard to see change come about.
- o And a few of those who work directly for the people who report to the Administator are doing so also.
- o But not many others.

Why not ?

Because the notion is still too new to them, and they have little if any experience in so doing.

They know for sure what they must do: the Shuttle must not fail in flight: the Space Station must come in on time and within budget: myriads of technological, operational and international problems must be worked out. That is, they are very, very, busy, and many have worked to acquire a Space Station for a decade and see the possibility of being associated with it for up to another decade, perhaps longer.

But Lower Costs ? Privatize ? Commercialize ? They're very, very busy doing what they are sure must be done.

And they observe that, although the Congress has explicitly asked them to do these things for over a decade, the Congress insists that they do other things too (see Associate Administrator Lee's instructive testimony statement, especially page 3) and the Congress has never overtly penalyzed any of them for not doing so.

Finally, many of them are understandably concerned about their future employment prospects in an era of budget reductions, and some see "commercialization" as an additional employment threat.

Question 2. "In general, how do the requirements of new private sector companies that are not looking to make their money from governmernt contracts differ from traditional aerospace contractors when they work with NASA?"

Answer:

- If they are start-up companies, their leaders must put their own funds at risk. Traditional space contractors have ways of using government funds to support themselves in their search for new government contracts. Therefore NASA sees more of the latter kind of organization able to work with them than the former.

- Such initial money, so difficult to come by, gets spent very fast -- and waiting for the "government process" to work out can be debilitating and oftentimes fatal. Many/most of the traditional companies, to varying degrees, have much "deeper pockets" and can afford to wait longer. Thus NASA tends to limit itself to the larger, older, "arsenal" (as the DOD puts it) companies.

- After decades of experience, the traditional space contractors know how to navigate through the Washington, D.C. political-bureaucratic waters with skill -- and these waters are much different from those encountered in the private sector. (Note the emphasis that Associate Administrator Lee placed upon how "different" the government procurement process is.) Many/most ordinary private businesses either do not have the resources or patience to "learn this game", and so NASA is denied their services.

- The traditional contractors are used to working on essentially a cost plus fixed fee basis. Of course this encourages longer, more complex and more costly contracts under which there is little incentive to cut costs. In the private sector, exactly the converse situation holds -- profit is the difference between an

acceptable market price and cost, so there is a constant striving to reduce cost and thereby increase profits. The latter private firms find it difficult to work with NASA and to obtain the large amounts of private profit-seeking capital needed to do so. (The testimony of David A. Rossi of SPACEHAB Inc. Rossi was instructive on this matter.)

- The government market is well known to NASA and our traditional space industries, relatively slow to change and, in the nature of things, influenced to a considerable extent by political circumstances. NASA is essentially the only customer. Outside of the expendable launch vehicle area, there is little large-volume activity: there is one Hubble space telescope, one Space Station, ... And there is little that the contractors can do directly to influence the size or character of its market. They are both working in a planned economy.

  But, in the private sector, there is a continuing emphasis upon increasing the size of the market so that the unit cost of assets and activities can be made smaller, so that the market will expand in response, so that costs can be reduced further, so that.... all of which leads to increasing profits. And there is always the entrepreneur who perceives a wholly new way to serve an existing market (e.g. satellite rather than shortwave communications) or of creating a new market altogether (e.g. television) and is willing to risk capital, time and energy to demonstrate that he/she is correct and, in a free enterprise economy, able to become wealthy.

  These latter organizations find it very difficult to work with NASA and many simply avoid doing so.

- NASA has a large number of smart, well educated and experienced space engineers. Many/most became of age, professionally, during an era when oftentimes there was relatively little space skill elsewhere. Today, there is such skill in the private sector but, in the nature of things, there remains a tendency on NASA's part to ask not only for performance from its contractors but, also, to insist upon how this performance is to be attained. This tends to stifle outside creativity, especially in matters of cost reduction in which, until recently, there has been relatively little interest, and which usually involves additional risk taking, which is seldom a comfortable route to take in a political context.

Question 3. "How do you think NASA's move to include station operations under the single prime contract for the space shuttle will affect the agency's ability to commercialize the space station and create your vision of "Alphatown?"

Answer: It is not unreasonable to expect that a single prime contractor for Space Station O&M could reduce its ongoing cost by several 10s of percent, as is expected of an analogous arrangement re our Shuttle fleet's O&M costs.

But, in order to see large and widespread economic growth in the human spaceflight area, it is clear that (as I testified on November 8, 1995) orders of magnitude reduction in these costs must be achieved in the process of both acquiring and using space infrastructure.

I do not judge it to be possible for a government contractor to do this, and to encourage the early commercialization of the U.S. portion of the International Space Station and its evolution into a "town" in LEO.

By law, a government contractor would have to work in the procurement climate so well described in the testimony of Associate Administrator Lee. Even if this climate could be marginally improved upon as she wishes, this is simply the incorrect climate for what needs to be done. Our government simply cannot be operated as a private business, which is what is fundamentally required regardless of the desires and intentions of NASA and any such contractor. Rather, a free enterprise climate must be created, and I am convinced that this can be done. (Please see the attached paper.)

Too, it would not be prudent or advisable to see any one such private contractor to the government placed in such a controlling position re our Country's leading effort to see the human spaceflight area become commercialized.

Question 4. "At previous times, you have argued against government development of a space station, suggesting instead that the private sector develop a space station for the government. Given the government's commitment to developing a space station, what gives you the confidence that private companies want any part of the station, except as traditional government aerospace contractors?"

Answer: The Space Station should be used, as is now expected, for three essential purposes: (a) to learn how to assemble and operate very large, massive and permanent structures in space, (b) to learn how people can survive and best function there, and (c) how to do fine microgravity research there.

But now, as well, three new factors can and should come into play:

- o "Privatization"

  We must learn how to move from a planned economy to a free entrerprise economy in the human spaceflight area, as we have long since learned how to do in some elements of the information area,such as satellite communications.

  Under proper circumstances, the Space Station program, with its multi-billion dollar annual O&M appropriations, could act, in effect, as an imaginative and effective "bank" during some transitional interval in which this comes to pass.

  Space Station government O&M services could be "privatized", i.e., provided on a lease basis by our private sector. The reasons for doing so would be to reduce government costs while, at the same time, giving such companies the opportunity to gain experience in space activities in a near free enterprise fashion, obtain significant cash flow, and gain credibility.

  In addition to O&M services, the same way of doing business should also encompass the acquisition of any additional Space Station assets: they should be offered to the government by private sector companies.

  This first step would position us to take the second.

- o "Commercialization"

  When it is demonstrably evident that large unit cost reductions in capital assets and ongoing O&M are achievable, such companies would advance to full "commercialization", for then private companies could afford to do business in space.

  They would provide private sector infrastructure attached to, or close by, the Space Station. And so the "town" would begin to grow, with the Space Station acting as its physical centerpiece and the Space Station program as its institutional centerpiece.

The government could also take advantage of such circumstances to undertake more and different activities than now planned for the Space Station on a minimal cost basis. Too, by then, the word "government" would no longer connote "Federal" alone -- State governments would be able to take advantage of such circumstances as well.

o "Market Research"

Throughout both epochs, portions of the Shuttle fleet and the Space Stsion would be provided by the government for the conduct of market research, just as they now are expected to be used for scientific research.

Wholly new space activities could be tried out on a "sample" basis to inquire into their public acceptance and how to maximize it.

Question 5. a) "Since the space station will remain a government-owned facility, how does selecting a commercial operator improve our ability to promote space commercialization?"

Answer: Please see my answer to question 3., above.

b) "How do we select an operator that does not limit its 'commercial space business' to winning government station contracts?"

Answer: I doubt seriously that this difficulty can be avoided under today's circumstances.

This was the question that prompted me to think out the kind of economically-related Space Station program oversight arrangement that would avoid such difficulties as this -- and that led to my writing of the attached paper.

c) "What steps can we take to ensure that the private sector companies providing goods and services to the space station use that government business as the first step in building a commercial space business that does not depend on government contracts or outlays for its success?"

Answer: I know of no way that the government can ensure that such takes place.

But:

- The leader of each such company would have to pledge to make a serious effort to do so in submitting his company's bid, thereby assuring the government that he understands what our Country's economic interests expects of him/her.

- If it is a traditional space contractor, it could as well be asked to create a separate company/division to bid on such a contract -- one pledged to seek private sector as well as government space-related business.

- But, finally, there is one incentive that is a much more powerful one than all others -- the classical free enterprise opportunity to make profits well beyond those possible in doing government contract work.

  Such a possibility will not look to be an opportunity by those in our space industry that wish to minimize their business risk and are willing to continue to work under a cost plus fixed fee arrangement.

  But, fortunately, there are all of the others.

  For instance, at this time I am working with several other space-interested businessmen and companies to create a privately financed and managed organization devoted to "privatizing" certain Space Station services. But our goal is to move beyond such "privatizing" as soon as possible and, employing space infrastructure of markedly increased capability and markedly reduced cost, enter into the provision of services that, in our judgement, would attract considerable private use.

  We expect that this "privatizing" (a) would lower the Space Station's ongoing O&M costs and operating risks, while (b) increasing its operating capabilities. And we expect to do so at a profit that reflects our business risks.

  Beyond this, we have already identified four Space Station/"town"-related commercial opportunities that our ability, by then, to provide unusual and lower unit cost infrastructure would position us to attract and serve.

  This latter is our more fundamental business goal.

"...THE FULLEST COMMERCIAL USE OF SPACE."

HOW THE UNITED STATES SHOULD NOW GO ABOUT ACHIEVING IT

T. F. Rogers

November 26, 1995

"The Congress declares that the general welfare of the United States requires that the National Aeronautics and Space Administration [should] seek and encourage to the maximum extent possible the fullest commercial use of space." [Emphasis added.]

Public Law 98-361

The National Aeronautics and Space Act of 1958, as amended in 1984

Abstract

The highest non-military space goal for the United States should now be to see space assets and activities used to further our economic interests. Economic growth now should be sought for primarily in the human spaceflight area.

In order to achieve this growth, the unit cost of basic space infrastructure -- surface-LEO transportation and in-orbit electrical energy, habitable volume and life support -- must be reduced by orders of magnitude.

There is no reason why, from a technological-operational perspective, this cannot be done if there is the will to do so and there are large enough private sector markets to be served. Were this done, large new business markets can be expected to come into being in the human spaceflight area as they already have in the so-called information area of satellite communications, etc.

In principle, this can be accomplished by thinking of the U.S. portion of the International Space Station as the physical centerpiece of a "town" in space, and using our Space Station program as a "bank", first to learn how to "privatize" the Station's services and then to see the "town" expanded, privately, to serve commercial and industrial purposes.

But it will not be possible to do this as a government program, for the government cannot be operated as a free-enterprise business -- it must conduct its activities with a present bureaucracy and space industry schooled and required to operate in a political, not an economic, context. Only the private sector, not the government, can be expected to achieve the required sharp unit cost reductions and commence diverse and large scale space businesses.

Therefore, it is mandatory that a new public-private institutional arrangement be created to do so -- one designed to see that our Shuttle, Space Station, X-33 and RLV programs are all carried on in concert with the aim of allowing and stimulating large-scale space economic growth.

One such arrangement is suggested. It should be given thoughtful study at an early moment by all concerned with the U. S. future in space.

Introduction

The first United States civil space era saw us focus upon the public defeat of the Soviet Union in a race to the Moon.

The second has been predominantly a cultural one -- a search for life throughout space and robotic exploration of the other planets of the solar system.

During this time our astronauts have been learning how to travel throughout the Earth's nearby space and to deal with the problems of residing and working in Low Earth Orbit.

And we have learned how to position man-made satellites in orbits around the Earth to be used for various cultural, social, economic and military purposes.

But the past decade has seen a diminished focus in the publicly funded civil space program, accompanied by a sharp drop in the program's general public constituency as compared to that of the 1960s-70s. Now, in order to maintain even a decreasing financial support in the program, reasons of publicly-supported employment and international political interests seemingly must be advanced.

It should now be clear to all who are seriously interested in our Country's future in space that our highest national non-military space goal must change. It must become that of seeing space assets and activities used to further our economic interests.

Four decades of lavish public spending upon civil space must now be succeeded by an interval of primary concentration upon the use of space for economic growth.

We must now use our accumulated knowledge about, and experience in, space to see our private sector's directly space-related revenues increased to more than $50 billion per year (inflation adjusted), i.e., to become a truly important national economic force, an order of magnitude larger than it is today. And we should strive to see this come about in less than two decades.

Instead of space remaining a government preserve, we should see, for instance: that many thousands of people are able to take trips to space every year -- not just a few professionals and guests of the government; a veritable explosion of much lower cost information-related services; hundreds of scientists conducting basic microgravity research in LEO to obtain a better understanding of the diseases and disabilities of our aging population; wholly new space sports, able to be viewed and enjoyed world-wide; novel space entertainments; ... .

In this way we would see that the great public cost of our civil space program has become a true and continuing economic investment, thereby confirming the public's confidence that this would eventually come about.

Too, at this annual revenue rate, one-half of the Federal taxes produced would allow a much more efficient civil space program to concentrate upon seeing our astronauts learning how to take up residence upon the Moon and striding out into the farther reaches of space on a continuing basis. That is, the Federal program would finally become self-sustaining -- it could then finally come to be considered institutionalized.

Context

After nearly forty years of technology, operational and business development, the directly space-related business revenues of the United States now approximates $8 billion per year, i.e., about 2/3 of the Federal civil space program budget. These business revenues are now growing at a 10%-15% per year rate (not adjusted for inflation).

But these revenues are essentially all concentrated in the information areas of satellite communications, navigation, position-fixing and remote sensing, and their related satellite launch sector.

U.S. space-related economic prospects would be substantially enhanced were business development to take place in the human spaceflight area as well -- the space area upon which our public has seen $100s of billions spent and which continues to be supported at a $5 billion per year rate.

But human spaceflight activities continue to be a government preserve, for only the public has deep enough pockets to support them. Private sector human spaceflight business activities simply cannot commence in the face of their paralytically great cost. These costs are 3 to 5 orders of magnitude greater than their Earth surface analogues (passenger transportation, electrical energy, living and working volume, ...).

Were these costs to be reduced enough, recent professional studies have concluded that a large number of commercial space businesses could be expected to come into existence. (See References 1, 2, and 3.)

Of course, in principle, these great costs can be reduced, sharply. (See Ref. 2.) But, in practice, they have not over the past four decades and, as matters stand today, they cannot.

For, while the Federal government certainly can be expected to accomplish certain things (to provide for our military security, to educate our children, to manage our airways, ...) in the nature of things it cannot be expected to reduce the cost of hardly anything, and certainly not by orders of magnitude. To attain the end of large cost reduction we must look to our private sector.

Unfortunately, most of our human spaceflight industry, no more than their related government offices, can be expected to reduce costs. It is schooled, experienced and regulated in a way of doing business that, to an excellent first approximation, is simply foreign to our private sector with the latter's continuing and fundamental concerns for the time cost of money and unit cost reduction efficiencies.

Too, our private sector almost always "thinks big", for it knows that, as production and service volumes increase, the opportunities to reduce unit costs also increase -- the business process can become more and more efficient. But the markets for our civil space industry are, for the most part, restricted to one Viking Lander, one Hubble Space Telescope, one Space Station, ... There is no such opportunity.

For instance, in the Space Station itself, as the result of conducting a program that will cost scores of billions of dollars throughout its planned acquisition and operating lifetime, we will obtain the professional services of only 2 to 3 Americans.

In contrast, this kind of economic behavior has been demonstrated in the space information areas. Year after year the cost per satellite communications voice or picture channel has decreased as the size of population served has expanded. And, as the market for satellite navigation receiver-computers has grown toward a million, the earliest cost has been reduced by orders of magnitude.

But this experience continues to elude the human spaceflight area.

Opportunity

Now, fortunately, we have an extraordinary opportunity to change today's economically-related space circumstances in the human spaceflight area also.

The Space Station program has recently begun to receive strong political support. If this support continues, once the Low Earth Orbit Space Station is placed into ongoing operation -- over an interval now expected to last a decade beyond the year 2002 -- this program, inclusive of required Shuttle fleet support operations, can be expected to receive Federal appropriations of $4-5 billion per year.

Therefore, we can begin to think of the Space Station itself not only as a Federal building in Low Earth Orbit but, rather, as the physical centerpiece of our first private sector "town" in space. (Ref. 4.) And we can think of the Space Station Program as the institutional "bank" to assist in the "town"'s continuing enlargement and prosperity.

That is, after its assembly is complete, all of the services and any additional assets needed by the Space Station could be provided by our private sector on a lease basis. This "privatization" of government services would enable those of our business community who are interested in, and inherently capable of, supplying Space Station goods and services much more efficiently than is the case today (a) to gain valuable experience in space, (b) to become credible space suppliers and (c) to generate cash flow to be used for further space enterprises. As the costs come down, these later enterprises would be ones of a true commercial nature.

It should be noted that the most important of the Space Station services is surface-Station transportation of cargo and passengers. Initially this service will use the Shuttle fleet, but essentially all are agreed that it should be replaced as soon as possible by a new commercial vehicle-fleet that is much more safe and reliable and that costs much less to deliver a pound of payload to LEO. The cooperative space industry-NASA X-33 program is expected to provide much of the technological-operational basis for the private acquisition and commercial operation of such a vehicle-fleet.

But it will be impossible for such a new vehicle-fleet to come into being absent a large government market for its services at the outset, for there is insufficient space industry confidence that large private sector markets will come into being in response to its appearance. Therefore, imaginative service and pricing arrangements will have to be arrived at by the government and our private sector, and they will both have to address the articulation and demonstration of new private sector markets as well -- and these activities will inevitably be reflected in the overall Space Station program.

Accomplishing this would see us solidly upon our way to replicating our successful space information area business experience in the human space flight area -- and a major step would have been taken toward achieving the space area's most important goal of all: markedly increased national economic growth.

And, it should be noted, that this kind of economic activity in the Space Station program would enhance its political support, which support would help to see the economic activity expand, which ... .

Problem

But, there is a problem.

Can we honestly imagine that our present government and industry space offices, and the space service and asset acquisition ground rules under which they operate, could undergo the fundamental changes required to conduct human spaceflight activities in primarily an economic rather than a political context ? -- And begin to do so at an early moment ?

No. We cannot.

The ground rules that underlie technology development, engineering and procurement decisions in the human spaceflight area have built up over decades and have their own internal logic. This internal logic is political -- not economic.

Could they be modified somewhat to improve government acquisition efficiencies and lower unit costs by 10s of percent, possibly even by 50-100% in some areas over a decade ? Probably yes, if it were judged to be important enough to the Federal Legislative and Executive branches. For instance, we expect to cut costs by "privatizing" the Shuttle program, and we are beginning to do so in the deep space probe area and in the Department of Defense expendable launch vehicle (ELV) area.

But, as the Associate Administrator for NASA's Office of Procurement noted recently: "The Government bears the responsibility for the good of all [and is expected to address] societal needs. [In this context] Numerous Congresses and Administrations have determined that [there] are valuable and necessary conditions of doing business with the Government [that] do increase costs and make doing business with the Government different. ..." (Ref. 5.)

Some examples:

- o In paying Federal personal income taxes, home owners who make mortgage payments are allowed to claim a deduction for mortgage interest expenses. While this places an additional tax burden upon all who do not make such payments, the government judges that the economic support that this offers to our housing industry and the social value of widespread home ownership are more important than efficient and egalitarian tax collection;

- o The Space Station will cost more than is technologically-operationally necessary. The same LEO capability could be provided by using a different, inherently lower cost, design. But for several reasons, among which is the large publicly funded employment opportunity that the Space Station program offers, acceptance of its present design characteristics is deemed to be more important than cost reduction -- just as closing a DOD base that is no longer of sufficient military value is oftentimes deferred;

- Some of the best ideas for lowering the unit cost of present Space Station-related assets and services will involve providing some of them in a quite different fashion than today -- ideas that will take time and money to carry through to the point where they would be taken as acceptable. But, except in unusual circumstances, when once presented to the government they will be treated with reference to The 1984 Competition in Contracting Act of 1984 which requires that government procurements be conducted using full and open competition. That is, because it is spending taxpayer funds, the government believes that all interested companies must be afforded the opportunity to participate. (Ref. 6.) And so the value of the idea originator's intellectual property may well be lost to him/her.

- When calculating the profit to be allowed on one of its contracts, "...NASA procurement practices require that [its] evaluators focus on the cost to the contractor instead of its value to NASA of the proposal." (Ref. 7.) And little if any consideration is given to the business risk that the proposer has had to take to position him/herself to obtain the contract with NASA. NASA officials thereby minimizes their own risk of "...sitting in this [hearing] chair before you [the Congress], or [appearing] on the front page of the Washington Post. A career can be ruined, a job lost." (Ref. 8) But, in so doing, NASA misses the opportunity to make large gains in efficiency-cost reduction, and it reduces the likelihood that the true entrepreneur will strive to obtain a NASA contract.

That is, there are many logics. And, in the government's collection and spending of public funds, political logic can usually be expected to prevail over economic logic -- just as in the private sector the opposite is expected to take place.

Indeed, the central thrust of the written statement of the senior NASA procurement official submitted at a House hearing recently was that of explaining why, although some improvements can be made in the NASA procurement process, NASA can do very little to answer, positively, the basic question: "Why don't you just operate like commercial firms ?" (Ref. 8.)

We simply cannot look to today's Federal government-space industry structure to bring about unit cost reductions of basic infrastructure in the human spaceflight area by orders of magnitude -- whether or not they wish to, and no matter how hard they might try. Our Federal government simply cannot be expected to operate like a private business. Yet without such large cost reductions there cannot be large, profitable, business activity there.

And, so, however encouraging the conceptual possibilities are for using our Space Station program to do so, under today's organizational, institutional and regulatory circumstances -- circumstances that cannot be expected to be allowed to change very much -- unit costs cannot be brought down sufficiently or soon, and our space economic aspirations will remain unattainable.

In this context thought is being given today to seeing the Space Station operated by a single prime contractor -- probably a major space industry organization or team. It may well be that doing so could result in service savings of several 10s of percent (as is expected for an analogous arrangement for the Shuttle program). Understandably, from the point of view of those responsible for civil space program budget matters, such a reduction is non-trivial.

But to imagine that a major space industry organization, operating under a cost plus fixed fee government contract, would have the imagination, drive, extreme cost consciousness, and contractural freedom to see Space Station unit costs soon reduced soon; to see other commercial space assets and activities formed about the Space Station which would have unit costs lower than the Station's by orders of magnitude; and to attract widespread, fast-paced and very imaginative entrepreneurial activity while still doing the government's bidding -- all of this is simply too much to imagine.

As well, many would consider that placing a private sector firm in sole charge of seeing how private sector business in the human spaceflight area is to be developed -- in effect a monopoly -- would not be a prudent move for our Country.

In brief: even with the full and explicit thrust of Federal law (see the Frontispiece) there has been hardly any movement at all toward achieving "... the fullest commercial use of space" in the human space-flight area over the 11 years since the law was enacted. This law has had little if any effect, probably because it conflicts with so many others that the Administrations have decided to give preference to that they could say they were responding "...to the maximum extent possible... ."

As matters stand today, no further charging of NASA and our present space industry about large and early economic growth can be expected to be useful, regardless of how much the Congress and the Administration may wish to see it come about.

Solution

Can anything be done ?

Yes.

But only if we think out a wholly new public-private institutional arrangement for achieving vigorous and early economic growth in the human spaceflight area, debate its specifics, and put it in place with appropriate legislation, soon.

In doing so it is well to reflect upon a most important and relevant space economic happening that took place in the early days of the space age -- the creation of the public-private arrangement that underlay the extraordinary success of the satellite communications business.

By 1960 it had become clear to an increasing number of communications scientists and engineers in the Department of Defense and the National Aeronautics and Space Administration that it should be possible to design satellite transmitter-receivers, launch them into orbit, and see them used with appropriate surface equipments to increase, greatly, the quality and reliabilty of the long distance communications then provided generally by shortwave methods and means. This view was shared by some in the communications industry -- most noteably by the (then) American Telephone and Telegraph Company.

But it was far from clear what the responsibilities and roles of DOD and NASA should be to see this space-related revolution come about. DOD's situation was less difficult -- the press of the cold war with the Soviet Union was a forcing and clarifying one, and DOD soon sensed that its specific strategic communications needs could not be met by a private sector instrumentality.

What then should be the responsibility of NASA in creating a new, potentially large and important, commercial business ? Could a government Agency be expected to know how to do the business of the communications giant, AT&T ? AT&T forced the issue by formally expressing a determination to see its own satellite placed into orbit and used by itself and French and British communications interests to establish trans-Atlantic cir- cuits. It asked the government to launch its "Telstar" satellite, pledg- ing to pay the government for doing so.

This, in turn, raised the question as to whether the public interest would be best served by seeing one major company given such a great initial business advantage -- in effect a monopoly.

After some considerable national debate, it was decided that a new communications entity should be created: the Communications Satellite Corportation -- COMSAT. It would have a broadly selected group of Directors, be our Country's chosen instrument for commercial satellite communications development, and would be provided most of its capital through the sale of stock to the interested public.

The great business success of COMSAT, especially over its first two decades, and its pathfinding role that subsequently allowed other companies to enter the satellite communications business, should encourage us to consider an analogous arrangement for the human spaceflight area.

Here is an initial suggestion:

- o A "Human Spaceflight Economic Development" entity of modest size, say an "ASTRACORP", would be formed.
- o ASTRACORP would be given the responsibility of hastening U.S. economic development and growth in the human spaceflight area.
- o ASTRACORP's activities would be based solidly upon the Space Station, Shuttle and X-33 programs, and it would have general oversight re all three insofar as economic considerations require.
- o ASTRACORP would employ ordinary business practices to see that the services required by the U.S. portion of the Space Station are provided by our private sector at the lowest unit prices and at the earliest moment. It would do this and other things to see the Space Station's public infrastructure enlarged through the addition of private sector infrastructure that would be used to accommodate commercial-industrial businesses.
- o ASTRACORP would arrive at understandings with the Federal government about the use to which the Space Station's capabilities are to be put, balancing among the interests of those who (a) need to learn more about how to reside and function in LEO, (b) are to conduct basic microgravity research there, and (c) need access to some portion thereof to conduct marketing and related R&D studies of an explicit economic nature.
- o Because of ASTRACORP's oversight of the use of public funds, and because of its sensitive monopoly position, some of the Directors of the entity would be appointed by the President; it would report to the Congress, formally and publicly, each year; and its books would be open to the Government Accounting Office.
- o For, say, the first 3-5 years ASTRACORP would be funded by the Federal Government out of a budget that is separate from NASA's. The budget size would be some $10 million per year. Thereafter, it would be expected to be funded from fees collected from companies that are receiving human spaceflight-related business revenues.

- o ASTRACORP would have a clear and explicit lifetime -- one restricted to, say, today's expected Space Station operational lifetime, i.e., some 17 years hence. This should be "transitional" time enough for the U.S. to move from today's extra-information space area planned economy to a free enterprise economy.

Of course, consideration of such a novel suggestion requires widespread and thoughtful study and debate. For instance, the government could ask some of our best University business school and private sector business consulting firm brains to give this entire situation, including the specific "ASTRACORP" suggestion, thoughtful study.

However, we must not delude ourselves about how difficult it will be to extend our fine economic success in the space information area into the human spaceflight area. For very new, sharply cost-cutting, technology must be developed and placed into operation, and large new space markets must be developed at the same time. In contrast, by the time that COMSAT came into being there was already five years of national experience in the development of the required technology, and the first operating circuits could be established within the next three years. And there was already a large enough private market for long distance communications services, and national and international institutional arrangements were already in place for providing them.

But taking some such approach as ASTRACORP is mandatory.

Absent one, we simply will continue to "dither" -- we will not be able "to get there from here". We will lose an important space-related economic opportunity. We may never see the United States obtain a satisfactory economic return from the hundred's of billions of dollars that we have spent, and the billions of dollars that we expect to continue spending each year, in the human spaceflight area.

And, as a consequence, we may well see an even greater downsizing of our publicly funded civil space program than is now contemplated. And other countries -- especially Japan with its pioneering and fast-paced space tourism business advances (Ref. 3.) -- could begin to move out ahead in the commercialization of human spaceflight.

References

1. "What The United States Must Do To Realize The Economic Promise Of Space", The Aerospace Research and Development Policy Committee of The Institute of Electrical and Electronics Engineers, Inc. (IEEE). -- United States Activities: December 17, 1993.

2. "The Commercial Space Transportation Study -- CSTS", the "Alliance" of Boeing, General Dynamics, Lockheed, Martin Marietta, McDonnell Douglas and Rockwell; May, 1994.

3. "Space Tourism: The Perspective from Japan and Some Implications for the United States", T. F. Rogers; The Journal of Practical Applications in Space; Winter, 1995, Vol. VI, Issue No. 2; pages 109-149.

4. "The First Human Town In Space", Rick N. Tumlinson; Space News; October 9-15, 1995; page 15.

5. Written statement of Ms. Deidre A. Lee, Associate Administrator for Procurement, NASA, before the Committee on Science, U.S. House of Representatives; November 8, 1995; page 3.

6. See Reference 5., pages 2-3.

7. Written statement of David A. Rossi, Senior Vice President for Business Development, SPACEHAB, Inc., before the Committee on Science, U.S. House of Representatives; November 8, 1995. Later in his statement, Mr. Rossi observes: "Industry may be interested in providing a new component of the International Space Station (ISS) on a commercial basis. ... Using commercial practices, industry may be able to develop and build [it] for $100 million. NASA's own cost analysis may indicate that $500 million would be required to develop an equivalent capability using standard government practices. Although industry could offer to sell [it] to NASA for $150 million, thereby saving NASA $350 million, current...procurement practices would require that NASA pay no more than $118 million."

8. See Reference 5., page 2.

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30 November 1995

The Honorable Robert S. Walker
Chairman
Committee on Science
United States House of Representatives
Suite 2320 Rayburn House Office Building
Washington, DC 20515-6301

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Committee on Science

Dear Chairman Walker:

Thank you again for the opportunity to present testimony at the November 8, 1995 hearing on "NASA Procurement in the Earth-Space Economy." The following are my responses to your follow-up questions from November 17.

1. *How do your company's requirements from NASA differ from those of a normal NASA contractor?*

SPACEHAB, Inc.'s strategy for developing commercial space infrastructure and services is based on anticipating government and commercial requirements, investing private funds to develop products or services to meet those requirements, and then selling directly to government and non-government customers.

This strategy is different from the traditional approach to aerospace programs. Usually, the government determines program requirements, establishes specific technical solutions to meet those requirements, evaluates the product and service in a competitive procurement lasting at least one year, establishes oversight procedures and overlays a management structure, then contracts on a cost-plus basis.

SPACEHAB, Inc. believes the traditional approach to government procurement is best suited to those programs that are at the leading edge of technology. For those types of programs, industry can benefit from NASA's technical and program management expertise and financial risks can be minimized using cost-plus contracting methods. Unfortunately, traditional methods are still used in many cases where the technology is well established and industry is prepared to invest private capital and assume substantial business risks through fixed-price contracting.

Although NASA has attempted to modify its procurement approaches, in practice little has changed. The recent release of the RFP for the Centrifuge Accommodation Module (CAM) is the most recent example of the traditional contracting approach. SPACEHAB, Inc. has decided that we cannot submit a proposal to provide a CAM because the RFP specifies how the CAM must be built rather than NASA's operational requirements. I am enclosing copies of letters SPACEHAB, Inc. submitted to NASA in response for requests to comments on the draft CAM RFP that explain in greater detail our differences with those of a traditional contractor.

2. *NASA does not currently practice full-cost accounting ... How do you think this will affect its ability to "value price" goods and services that it would procure from the private sector?*

NASA does not have to practice full-cost accounting to determine if a price offered for a commercial product or service is reasonable.

NASA has extensive data on the cost of space products and services that it has purchased in the past. Also, NASA has a large staff of capable procurement officers and technical managers who can conduct an appropriate, unbiased analysis if desired. This type of analysis should be conducted today anyway to estimate the costs of all space programs and to prepare budget requests to Congress. Finally, NASA could procure outside consultants, accounting firms, or econometric firms that specialize in such analysis if necessary.

3. *Have you worked with the NASA ombudsmen?*

SPACEHAB, Inc. has not worked with the NASA ombudsmen. However, I will arrange a meeting to ensure that the ombudsmen is aware of our issues.

4a. *How has your company been able to leverage its contracts with NASA to build a commercial space business with non-government customers for your services and products?*

Leveraging SPACEHAB, Inc.'s contracts has been difficult in the past for three reasons.

First, SPACEHAB modules are carried aboard the Space Shuttle. The price that NASA has been required to charge for Space Shuttle launch services has been too high to attract users, either commercial or international space agencies. For example, the price to use only one locker on a SPACEHAB module mission must include approximately $1 million for Space Shuttle transportation.

Second, NASA's Space Shuttle pricing policy precludes adjusting the price according to a potential customer's ability or desire to pay. All users of the Space Shuttle must pay the same price to achieve a "fair" result. Commercial transportation systems often have different pricing structures for different customers based on their unique requirements or desires. (The airline industry is the best example.) Flexibility in pricing could attract more transportation revenue to NASA because no (or very few) users can afford to pay the current price and therefore NASA receives no transportation revenue today.

Third, NASA has developed in-house capabilities that provide services that are similar to SPACEHAB modules. There has been a tendency in the past to promote the use of these assets rather than to use commercially provided capabilities.

4b. *Does your continuing relationship with NASA create any obstacles to doing this?*

The Space Shuttle pricing policy is still an obstacle to achieving commercial activities in space. Progress has been made in areas such as protein crystal growth that indicate that a market does exist for space-based research and product development. However, the price of space transportation must be reduced substantially (perhaps based on the marginal, variable cost of a mission) and flexibility must be permitted to charge different customers different prices based on their requirements.

4c. How would you like to see that relationship change in order to build a commercial space business based on non-government customers?

Commercial space activities can be promoted to encourage non-government use in three ways.

First, NASA could buy many space products and services based on NASA's performance requirements not on technical specifications. Today, NASA routinely buys computers and other high-technology equipment off-the-shelf without specifying technical solutions. When NASA buys an IBM computer, NASA does not tell IBM how to manufacture the computer, determine what integrated circuits should be used, or mandate a specific quality control program. Many products or services more directly used in space activities could be procured this way.

Second, NASA's procurement policies could recognize that prices can be lower for products and services using commercial approaches and should focus on the value received by NASA rather than the cost incurred by the contractor.

Finally, a Space Shuttle transportation pricing policy that is flexible and does not attempt to recover development costs or fixed operating costs will open opportunities for companies to develop space infrastructure and to conduct industrial space research, development, and production.

Please let me know if I can provide any additional information.

Best regards,

David A. Rossi
Senior Vice President

Enclosure

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30 October 1995
SH-HOU-LTR-MK-950011

National Aeronautics and Space Administration
Johnson Space Center, Space Station Program Office
Attention: OG3-35/Steve Miley
2101 NASA Road 1
Houston, Texas 77058-3696

Subject: DRAFT REQUEST FOR PROPOSAL (RFP), CENTRIFUGE ACCOMMODATION MODULE (CAM)

Dear Mr. Miley:

Our October 23, 1995 letter advised the government that it would be difficult for us to respond to this solicitation as it is currently structured. We expressed our concerns at the one-on-one meeting on October 24, and you offered us the opportunity to identify specific changes to the draft statement of work (SOW). After additional analysis, we have confirmed our position that the primary concern is not with specific wording or individual requirements. Although we could offer suggestions to improve the SOW or the Prime Item Development Specification (PIDS), the underlying barrier to our participation would remain unless there is a significant change to the RFP.

This solicitation has one overriding characteristic: The CAM is a development program to be managed by NASA and the Station Prime using established International Space Station practices and processes. For example, some 29 of 41 documents mandated in the applicable document section of the SOW require adherence to ISS standard processes. The CAM contractor is not only required to have a quality assurance program, it must be the Station Quality Assurance program; the CAM contractor is not only required to have a configuration management program, it must be the Station Configuration Management Program; etc.

In addition, the technical specification may be more complex than necessary. The CAM SOW and PIDS have over 16 pages in various sections devoted to the specifications of the Command and Data Management Systems alone. By contrast, the entire specification for these systems for the SPACEHAB modules on Shuttle Mir missions is contained in one page of text in the SOW. There is no other specification, except the appropriate ICD's with the Orbiter.

For potential offerers with existing systems that can be adapted for use as the CAM without a full scale development program, the requirement to adhere to all ISS hardware specifications and development processes leads to a great deal of documentation that does not increase the capability of the hardware, but does drive up cost.

Our previous program experience illustrates the value of a less restrictive commercial approach. In less than 3 years from contract initiation to first flight, SPACEHAB developed a habitable and fully-resourced space research laboratory module, using commercial practices, with no compromise in flight safety, hardware quality, or reliability. Our Commercial Middeck Augmentation Module (CMAM) fixed-price contract with NASA has been entirely successful over three flights with no missed schedules and no increase in contract price. This contract, which includes end-to-end services for payload integration, mission integration and operations support, has been accomplished with a total of thirteen NASA deliverables and

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minimum government oversight. These deliverables are adaptable in format and content to multiple programs and served as the basis for definition of the complement of seventeen deliverables for our Station Phase One Contract (SPOC) with NASA. Throughout these programs, SPACEHAB flight systems, processes, and documentation methods have been shown to be effective and efficient, and fully compliant with NASA safety, certification and operations requirements.

Our commercial approach has proven to be an advantage to government . An independent "should cost" analysis commissioned by NASA using government cost models showed that a "business as usual" procurement approach for the CMAM capability would have cost 5 times more than it cost SPACEHAB, Inc. The key to these savings was NASA's willingness to let the contractor manage the program and to limit specifications to capability statements while requiring minimum specific processes or products.

In order to be able to offer NASA the required CAM capability using these proven methods, the fundamental structure of this RFP must allow a "best value" commercial approach. Please consider delaying the release of the RFP in order to structure the solicitation to allow commercial offers of existing systems under the basic SOW.

Sincerely,

Michael E. Kearney

Michael E. Kearney
Director, Space Station Applications

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23 October 1995

National Aeronautics and Space Administration
Johnson Space Center, Space Station Program Office
Attention: OG3-35/Steve Miley
2101 NASA Road 1
Houston, Texas 77058-3696

Subject: Draft Request for Proposal (RFP), Centrifuge Accommodation Module (CAM)

Dear Mr. Miley:

SPACEHAB, Inc. has made a determination that it would be difficult for us to respond to this solicitation as presently structured for three reasons:

(1) The Request for Proposal (RFP) incorporates "business as usual" completion form contract requirements that unnecessarily encumber an existing design with development processes, and that limit flexibility in submitting attractive financial arrangements;

(2) While we understand that the RFP provides the opportunity to submit an alternate solution that could increase the value to the government, the constraint that we must first provide a fully compliant basic proposal will force us to invest resources to fabricate an artificial solution to allow us to submit our best value proposal; and

(3) Although the development processes and specifications in this RFP are appropriate for the International Space Station (ISS) development program, when applied to the CAM they tend to favor the Boeing laboratory over existing modules.

Our assessment is that full and open competition would be better served if this procurement were delayed. With the CAM launch currently scheduled for 2001, and with most, if not all, of the known competitive designs based on mature or existing technology, we believe that allowing additional time to structure the RFP to accommodate a broader range of alternatives would allow more proposals to be compliant with the RFP and improve the competitive response.

Product specifications and development processes should be tailored to eliminate requirements that force unnecessary changes to existing designs. Activities and products, including data requirements, that may not have value equal to their cost should be deleted. Consideration should be given to waiving the specification for "Buy American" since several of the competing designs may be based on products supplied by NASA's international partners. By streamlining the RFP, the government would minimize the penalties on designs that are not part of the ISS baseline and reduce the ultimate cost to the ISS Program.

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The requirement for a completion-form, cost-type contract limits business alternatives. In order to enable competitors to offer the least cost solution to the government, greater flexibility should be encouraged in the basic proposal, including a hardware lease approach if it can be shown to be beneficial to the government.

We believe that the government can increase competition, reduce program cost, and streamline the evaluation process by structuring to maximize competition under the basic RFP. We will be prepared to discuss these comments at your earliest convenience.

Michael Kearney

Michael Kearney
Director,
Space Station Applications

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